The Engineer

UNIVERSITY OF MICHIGAN
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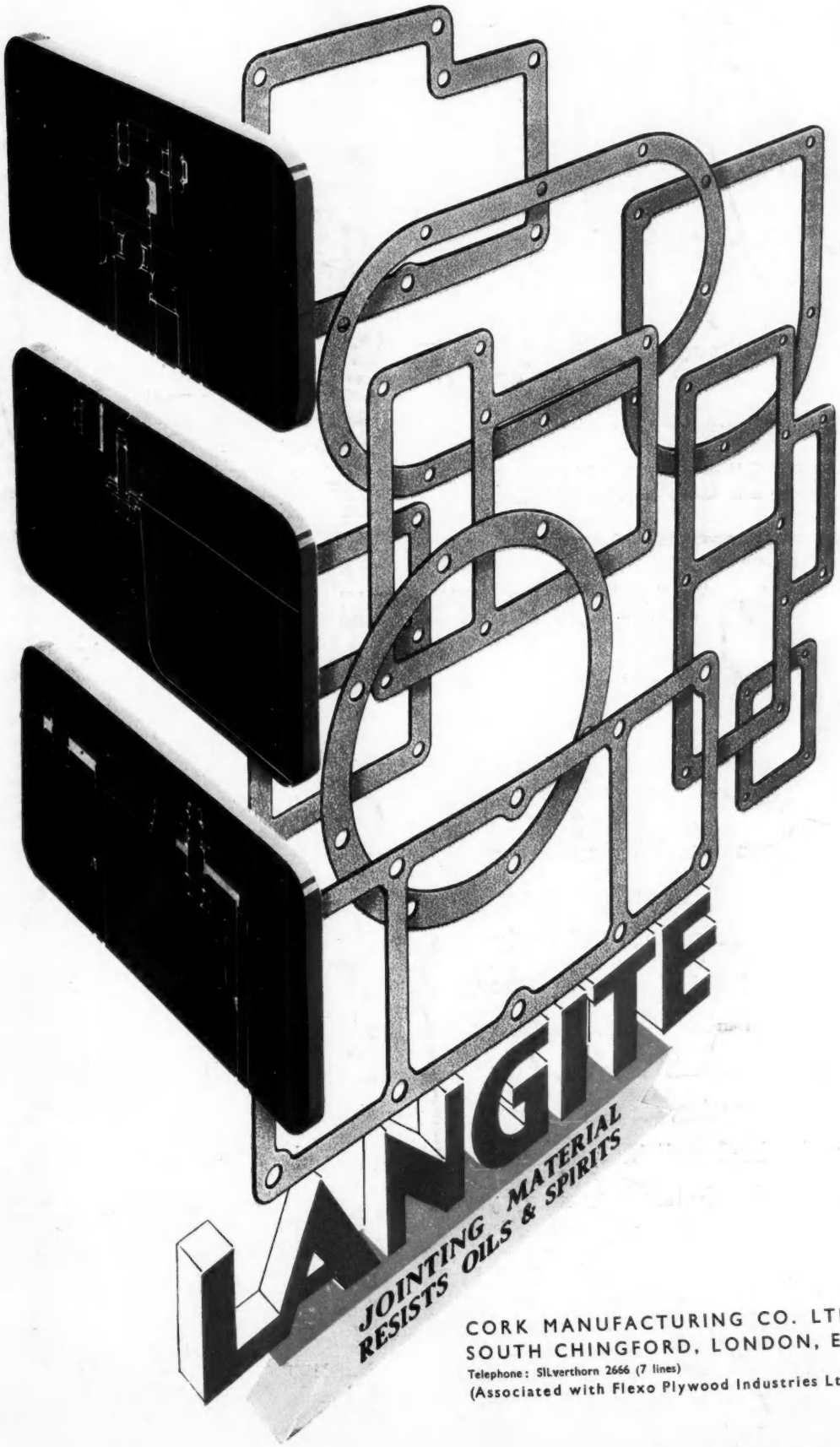
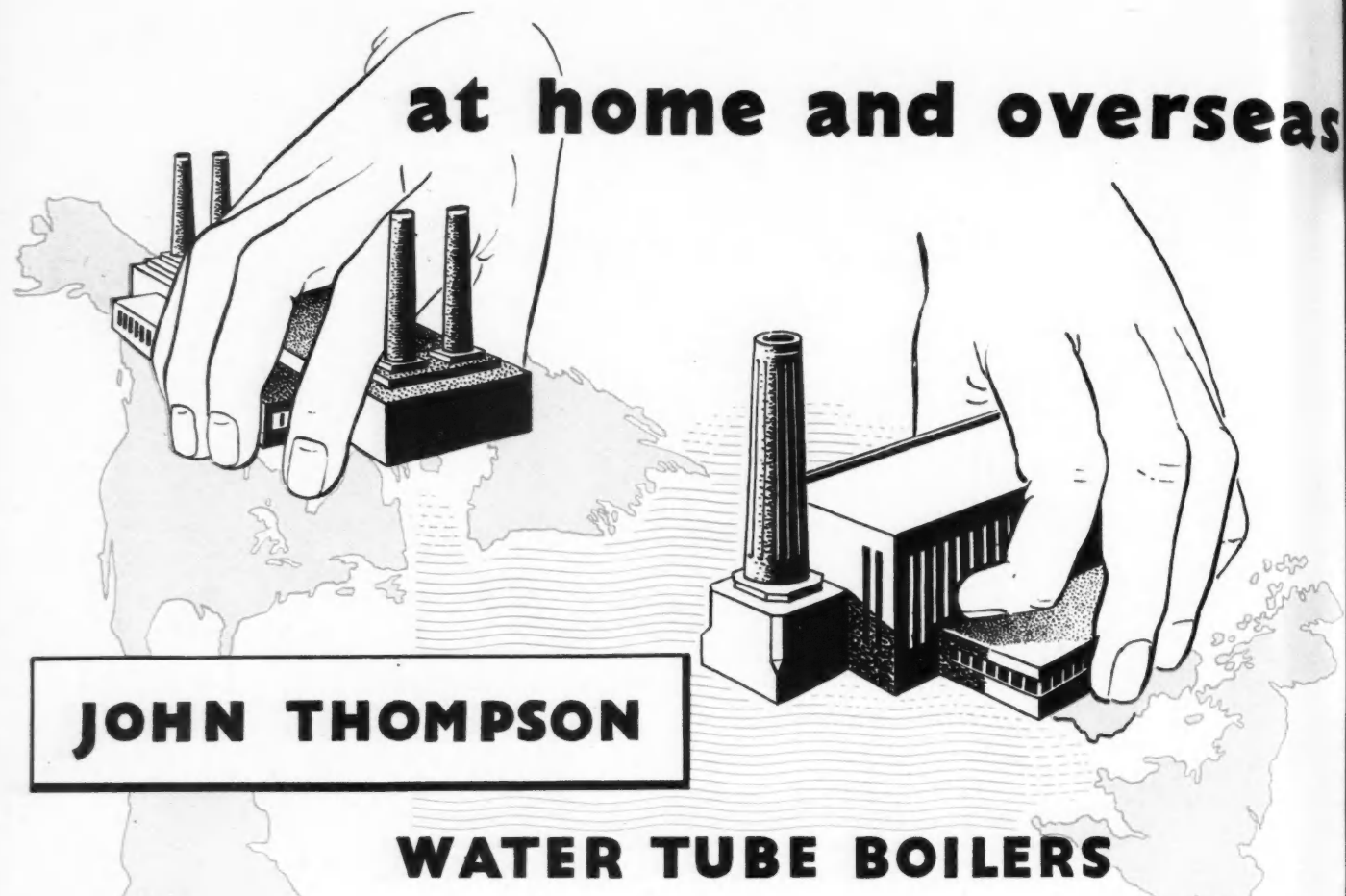
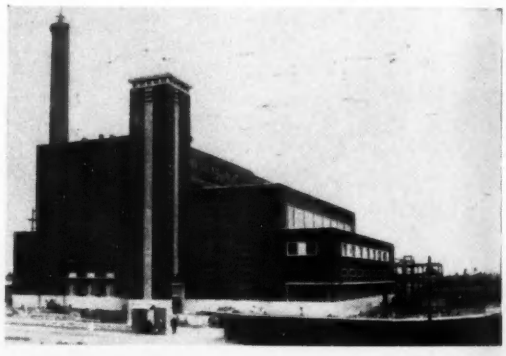


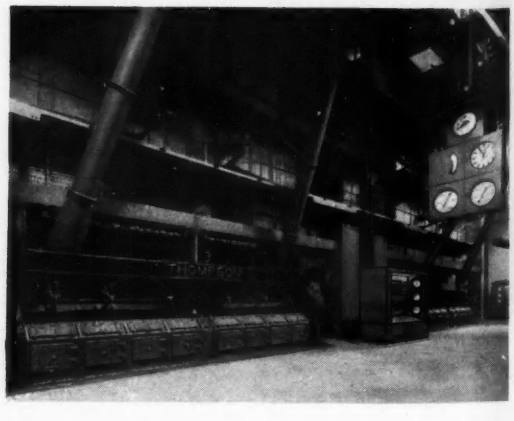


at home and overseas

JOHN THOMPSON

WATER TUBE BOILERS





Some 114 years ago in Wolverhampton, William Thompson made it his business to produce *good* boilers. Today power stations as far apart as Wolverhampton and Melbourne are proving that Thompsons have carried on this tradition of good boilermaking. These installations and others operating in this country, Europe, India, South Africa, South America, etc., have shown the high efficiency and maintained availability in service of John Thompson Water Tube Boilers over many years.

JOHN THOMPSON WATER TUBE BOILERS LTD.

ETTINGSHALL · WOLVERHAMPTON · ENGLAND

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VISCO-BETH
AUTOMATIC
Dust Collectors

In the manufacture of cement, fertilizers, soap powder, flour, dried milk, and other powder materials, an appreciable quantity of the product is often lost at grinding mills, conveyors, and packing machines. Liberated as air-borne dust it makes working conditions unpleasant and settles on floors, walls and machines.

In hundreds of factories, this dust problem has been solved by the installation of "Visco-Beth" Automatic Dust Collectors. In Australia, Ceylon, India, Iraq, Malaya, Mexico, South Africa, as well as in Britain, "Visco-Beth" Automatic Dust Collectors are keeping factories free from dust and ensuring maximum output by preventing waste of saleable material. They can do the same for you.

Our brochure "Modern Dust Collection" deals fully with the subject. Ask for copy.

Four of eight "Visco-Beth" Collectors in the Government of India Fertiliser Factory, Sindri.

Consult us on your Dust Problems

VISCO ENGINEERING CO LTD. STAFFORD RD. CROYDON

THE ENGINEER

ESTABLISHED 1856

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SEPTEMBER 18, 1953

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NOTICE TO READERS

All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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WORDING OF ADVERTISEMENTS: Approximately the first 25 letters of each advertisement are set in heavy type. Advertisers are therefore advised to begin their advertisements with the words they want emphasized.

Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC APPOINTMENTS

CANTERBURY UNIVERSITY COLLEGE

CHRISTCHURCH, NEW ZEALAND

LECTURER OR SENIOR LECTURER IN MECHANICAL ENGINEERING

Applications are invited for the post of LECTURER or SENIOR LECTURER in MECHANICAL ENGINEERING. Applicants must have a Degree in Mechanical Engineering of a recognised University.

Salary scale for a Lecturer is £800 by £50 to £950 per annum, and for a Senior Lecturer £1000 by £50 to £1200 per annum.

Further particulars and information as to the method of application should be obtained from the Secretary, Association of Universities of the British Commonwealth, 5, Gordon Square, London, W.C.2.

The closing date for the receipt of applications in London and New Zealand is 15th October, 1953. E5367

DEWSBURY AND BATLEY TECHNICAL AND ART COLLEGE

Principal : C. W SHACKLOCK, Ph.D., M.Sc., F.R.I.C.

TEACHER IN THE ENGINEERING DEPARTMENT

Required for January, 1954, or earlier, if possible, a suitably qualified TEACHER in the Engineering Department, to teach Mechanical Technology, Engineering Science and Engineering Drawing to Ordinary National Certificate level. Salary in accordance with the Burnham Scale for Assistants, Grade A (£415 by £18 to £670), with allowances : (a) within the scale for industrial experience and war service ; and (b) above the scale for Degree (or equivalent) and full-time training.

Forms of application may be obtained on receipt of a stamped, addressed envelope from the Clerk of the Governors, Education Office, Halifax Road, Dewsbury, to whom they should be returned within two weeks of the appearance of this advertisement. E2467

SURREY EDUCATION COMMITTEE

WIMBLEDON TECHNICAL COLLEGE, GLADSTONE ROAD, S.W.19

HEAD OF THE MECHANICAL ENGINEERING DEPARTMENT

Applications are invited for the post of HEAD of the MECHANICAL ENGINEERING DEPARTMENT to take effect on 1st January, 1954, or as soon as possible thereafter.

Candidates should have had good industrial and teaching experience. Salary : Burnham Scale for Heads of Departments, Grade II (Men), £1000 by £25 to £1150 p.a., plus £40 p.a. special addition, and London allowance.

Particulars of the post and application form may be obtained from the Principal, to whom the application shqild be returned not later than two weeks after the appearance of this advertisement. E5273

THE COLLEGE OF AERONAUTICS

(CRANFIELD, BEDFORDSHIRE)

DEPT. OF AIRCRAFT ECONOMICS AND PRODUCTION

DEMONSTRATOR

Vacancy occurs for a DEMONSTRATOR, capable of supervising post-graduate students on jig and tool design, conducting investigations into production methods and demonstrating use of metrology equipment. Commencing salary within range £350–£650, extending by annual increments to £750, with superannuation under F.S.S.U. and family allowance. Further particulars available.—Applications to the Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks. E5333

LONDON COUNTY COUNCIL

WANDSWORTH TECHNICAL COLLEGE

Wandsworth Technical College, January, 1954. Required for S.T.S. (roll 300), providing three-year course for boys entering engineering and allied trades, MASTER, to be responsible to Principal for organisation and running of school. Some teaching. Keen interest in technical education essential. Salary, Burnham (P. and S.) Scale plus London allowance and £200 special responsibility allowance.—Application forms from Secretary at College, Wandsworth High Street, S.W.18, to be returned by 2nd October, 1953. (996.) E5324

THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION

OPERATIONAL RESEARCH SECTION

TECHNICAL RESEARCH ASSISTANT

TECHNICAL RESEARCH ASSISTANT required by the Operational Research Section of the above Association, to assist in work study investigations concerned with raising productivity in iron and steel works.

Candidates should be interested in research and have some engineering or mathematical ability.

Starting salary according to age, qualifications and experience up to £580 p.a.

Written applications only to Personnel Officer, B.I.S.R.A., 11, Park Lane, London .W.1. E5331

PUBLIC APPOINTMENTS

CIVIL SERVICE COMMISSION

INLAND REVENUE

SECOND AND THIRD-CLASS VALUERS

The Civil Service Commissioners invite applications from qualified VALUERS, Men and Women, for pensionable posts in the Valuation Office in England and Wales and in Scotland. Vacancies are in both District (Revenue and Compensation) and Area (Rating) Offices, and include some posts for the valuation of minerals, factories and plant, licensed property, and agricultural tenant-right. Rating and mineral vacancies are limited to England and Wales. Vacancies in the Second-Class Valuer Grade are limited to posts for the valuation of minerals. Age at least 25 and under 36 on 1st October, 1953, with extension for Regular Service in H.M. Forces. Inclusive remuneration (men in London on 45½-hour week) : Second-Class Valuer, £1048–£1437 ; Third-Class Valuer, £678 (at age 25)–£1048. Starting salary according to age up to £945 at age 34. Somewhat lower for women and posts outside London. Prospects of promotion to higher grades. Candidates must have passed the Final Examination of the Royal Institution of Chartered Surveyors, or the Chartered Auctioneers' and Estate Agents' Institute, or the Land Agents' Society, or have a University Degree exempting therefrom, and must have at least four years' professional experience. For posts involving the valuation of minerals four years' mining experience will be required in place of the professional experience specified above and possession of a First-Class Certificate of Competency (Mine Managers), or the passing of the Final Examination of the Royal Institution of Chartered Surveyors (Mining Sub-Division), will be accepted as professional qualifications.—Fuller particulars and forms of application from the Secretary, Civil Service Commission, 6, Burlington Gardens, London, W.1, quoting No. 148–149/53. Completed application forms must be returned by 22nd October, 1953. E5303

KUMASI TOWN COUNCIL

GOLD COAST

ASSISTANT TOWN ENGINEER

Applications are invited for the post of ASSISTANT TOWN ENGINEER. Appointment will be for two tours of 18 to 24 months in the first instance, subject to six months' probation. Salary £1000 a year, rising to £1280 a year, according to qualifications and experience, plus overseas pay (if applicable) of £350 a year. Furnished bungalow provided at yearly rental of £60/£90. Seven days' leave for each completed month of residential service, plus travelling time after each tour. Free first-class passages for officer, wife and up to 3 children under 13 years o age. Candidates between 26/36 years of age must be chartered civil engineers and/or municipal engineers. They must have had experience in design, construction and maintenance of general building and civil engineering works, including roads, supervision of labour, preparation of bills of quantities, specifications, contract documents, &c. Previous local government and/or town planning experience will be a recommendation. Service with an engineering unit of the Armed Forces will be taken into consideration. Salary commences on sailing date. Applications, giving full details of qualifications and experience, together with copies of not less than three recent testimonials, should be submitted by Air Mail to the undersigned. It is suggested that applicants should cable as early as possible, giving bare details to qualify for consideration on the arrival of complete information.

FRANK W. BEECHAM, Town Clerk.

Municipal Offices, P.O. Box 40, Kumasi, Gold Coast, B.W.A. E5306

MINISTRY OF SUPPLY

R.A.E., FARNBOROUGH, HANTS

ENGINEERS

Ministry of Supply, R.A.E., Farnborough, Hants, requires ENGINEERS to assist in investigations and development work on installation of armament equipment in aircraft. Minimum qualification, Higher School Certificate (Science) or equivalent, but Degree or H.N.C. in Engineering may be an advantage. Experience of experimental work using electronic recording techniques essential. Salary within ranges : Experimental Officer (min. age 26), £649–£799, or Assistant Experimental Officer, £264 (age 18)–£576. Women somewhat less. Appointments unestablished.—Application forms from M.L. and N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D 354/53A. E5298

NORTH-WEST METROPOLITAN REGIONAL HOSPITAL BOARD

ENGINEERING DEPARTMENT

REGIONAL ENGINEER

The Board propose to make a new appointment of REGIONAL ENGINEER to control the Engineering Department at present under the direction of the Regional Architect, and comprising mechanical, electrical and heating and ventilating sections. Applicants must have one or more of the recognised qualifications in these branches of engineering. Good administrative and engineering experience essential, including hospital engineering in an executive capacity. Salary scale £1600 by £75 to £1975 plus £50 London weighting.—Applications, stating age, qualifications, and experience, together with the names of three referees, to be sent to the Secretary, North-West Metropolitan Regional Hospital Board, 11a, Portland Place, London, W.1, by 30th September, 1953. E5288

PUBLIC APPOINTMENTS

ADMIRALTY

ADMIRALTY ENGINEERING LABORATORY

JUNIOR DEVELOPMENT ASSISTANTS

Vacancies exist at the Admiralty Engineering Laboratory, West Drayton, for JUNIOR DEVELOPMENT ASSISTANTS, for experimental and development work in connection with electrical equipment of warships.

Candidates must be British subjects and should normally have served an engineering apprenticeship or have had equivalent workshop experience, and possess Ordinary National Certificate in Electrical Engineering or acceptable equivalent.

Experience in laboratory work and a knowledge of applications of electronic and telecommunication techniques to engineering development will be an advantage.

Appointments will, in the first instance, be unestablished, but there will be an opportunity to compete for establishment.

Salary of successful candidates will be assessed according to age, qualifications and experience, within the range extending to £613. Prospects exist of promotion to Development Assistant Grade (£608–£718 p.a.).

Applications, stating age, technical qualifications, apprenticeship and subsequent experience, should be addressed to Admiralty, C.E. II, Room 83, Empire Hotel, Bath, quoting "DA/AEL."

Candidates required for interview will be advised within three weeks of receipt of application. E5301

SUDAN GOVERNMENT

MINISTRY OF AGRICULTURE

RESEARCH DIVISION

Vacancies exist in the Research Division of the Ministry of Agriculture for the following posts :—

ONE SOIL CHEMIST.
TWO PLANT BREEDERS.
ONE AGRONOMIST.
ONE STATISTICIAN.
THREE CIVIL ENGINEERS (Soil Conservation Section).
TWO AGRICULTURAL ENGINEERS (Engineering Division).

Applicants should have appropriate Honours Degrees or their equivalents. Age limits 22–45.

Appointment will be on short term contract (with bonus) for an indefinite period, determinable at any time by six months' notice on either side, providing that on or after April 1st, 1955, the period of notice shall be three months and not six.

Salary scale is £E.1075 to £E.1675. Starting rate of pay is fixed according to age, qualifications and experience of selected candidates. A variable cost-of-living allowance is payable. An outfit allowance of £E.50 is payable when the contract is signed. Free passage on appointment.

Further details and application form will be sent on receipt of a postcard only, addressed to the Sudan Agent in London, Sudan House, Cleveland Row, St. James's, London, S.W.1, quoting the post applied for and name and address in block letters. E5279

MINISTRY OF WORKS

ENGINEERING DRAUGHTSMEN

ENGINEERING DRAUGHTSMEN required in LONDON, at RISLEY (Nr. Warrington), and BEDFORD. Hostel accommodation at Risley, possibly housing at Bedford.

Experience required in one of the following categories :—

MECHANICAL : layout of factory installations, including process plant, steam boilers and steam distribution, pumping, refrigeration and air conditioning.

Development of mechanical plant for a variety of research projects, including rotating machinery, heavy and light mechanisms, servo systems and pressure vessel applications.

HEATING AND/OR VENTILATING : the design of all types of heating and/or ventilating systems and general domestic engineering installations for all classes of buildings.

Salary : London, £396–£628 ; Risley and Bedford, £374–£597, according to age and experience.

Applicants should have British nationality, technical standard of O.N.C. or equivalent, and have apprenticeship or suitable practical experience of at least three years, one in a drawing-office. Promotion and pension prospects.

State age, nationality, details of training, experience, to W.G.10/C.E.2 (B), Ministry of Works, Abell House, John Islip Street, S.W.1. E9907

SUDAN GEZIRA BOARD

ASSISTANT MECHANICAL ENGINEER

The Sudan Gezira Board requires an ASSISTANT MECHANICAL ENGINEER, aged 28 to 42, or thereabouts, for service in the Sudan.

Candidates must be sound mechanical engineers who have served a recognised apprenticeship, with administrative and organising experience and capable of taking charge of a new project without immediate supervision. They must be prepared to work themselves on unorthodox experimental lines.

Appointment will be on probation for short-term contract for three years in the first instance, which period may be extended if necessary. Salary would be in the region of £E.1300 per annum, plus house and hard furnishings. A cost-of-living allowance is also payable. Free passage on appointment, annual home leave. There is at present no income tax in the Sudan. Candidate selected will be expected to learn Arabic as soon as possible.

Application forms will be sent on receipt of a post-card only addressed to the Sudan Agent in London, Sudan House, Cleveland Row, St. James's, London, S.W.1, quoting "Assistant Mech. Engr. 2412," and name and address in block letters. E5295

PUBLIC APPOINTMENTS

AMENDED

CIVIL SERVICE COMMISSION

PROFESSIONAL ENGINEERS IN VARIOU GOVERNMENT DEPARTMENTS

The Civil Service Commissioners invite applic tions for about 75 pensionable POSTS in a wi variety of Mechanical and Electrical Engineeri Duties. Applications will be accepted up to 31 December, 1953.

Candidates must be under 35 on 1st January, 195 with extension for Regular Service in H.M. Forc and up to two years for permanent Civil Servic For the Post Office they must be at least 21, for t Ministry of Supply and Ministry of Civil Aviation least 23, and for all other Departments at least 25 that date.

Generally, a candidate must possess a Universi Degree in Engineering or be a Corporate Memb of one of the professional institutions—Mechanic Engineers, Electrical Engineers, or Civil Engineers or have passes in, or exemption from, Sections A an B of the corresponding Associate Membersh examinations. Exceptionally candidates of hi professional attainment, but without the specifie qualifications, may be admitted. For some pos Associate Fellowship of the Royal Aeronautic Society or an Honours Degree in Physics will b accepted.

Salary scale (men in London), £650 (at age 25) £1000. Starting salary according to age up to £900 34. Candidates entering below age 25 will start salaries varying from £450 at age 21 to £570 at a 24. Prospects of promotion. Salaries of next high grades are £1000–£1320 and £1375–£1575. Some what lower for women and in the Provinces.

Further particulars and application forms fro Civil Service Commission, Scientific Branch, Trinida House, Old Burlington Street, London, W.1, quotin No. S85/53. E5300

SURVEYOR OF SHIPS (ENGINEER AN SHIP)
SURVEYOR OF SHIPS (SHIP)

HONG KONG GOVERNMENT

SURVEYOR OF SHIPS (ENGINEER AND SHIP) (a) (M2A/30148/EH), and SURVEYOR O SHIPS (SHIP) (b) (M2A/30149/EH), required b the Hong Kong Government Marine Department o probation for pensionable employment. Salary, &c. according to experience, in scale equivalent to £1442 rising to £1981 a year. Additional allowance up t £295 a year for married men according to dependants Free passages, liberal leave on full salary. Candidate for post (a) should hold an Extra First Class M.O.T Certificate or a University Degree in Engineering (o equivalent technical qualification), plus a First-Clas Steam and Motor M.O.T. Certificate. Alternatively candidates holding a First-Class Steam and Moto M.O.T. Certificate, plus experience as a surveyo superintendent engineer, &c., will be considered Candidates for (b) must hold a University Degree i Naval Architecture or an equivalent qualificatio and have attained a position of responsibility in a shipbuilding or ship-repair establishment. The must have been trained in the theory and practic of ship design construction and repair and have ha subsequent practical experience.

Write to the Crown Agents, 4, Millbank, London S.W.1. State age, name in block letters, full quali fications and experience, and quote reference numbe against the post for which application is made. E5305

AIR MINISTRY

EGYPT

TRADESMEN

The following TRADESMEN are urgently required on a contract basis for service at stations in Egypt:—

DIESEL-ENGINED POWER-HOUSE STAFF (Shift Engineers, Engine Driver Fitters, Engine Drivers).

MECHANICAL and ELECTRICAL CHARGE-HANDS.

FOREMEN OF TRADES (Mechanical Transport).

FOREMEN ELECTRICIAN and E.H.V. CABLE JOINTER.

CHARGEHAND OPERATORS (Civil Engineering Plant).

FITTERS (Civil Engineering Plant).

FITTERS, with refrigeration experience.

Pay at 20 per cent. above London rates. Additional foreign service allowance of £305 a year for married men and £165 a year for single men. Initial outfit allowance of £30. Passage paid out and home. Income tax concessions. Contracts are for three years and may be renewed. Applicants should be between the ages of 25 and 49.

For full details and application form send a post-card to Air Ministry, Directorate-General of Works, W.G.1(b), Bush House, South-East Wing, Strand, London, W.C.2. E5304

MINISTRY OF WORKS

ASSISTANT CIVIL ENGINEERS

ASSISTANT CIVIL ENGINEERS are required for work at Windscale, Cumberland. Candidates must be of British birth, must have experience of work on site, and have passed :

(a) Sections A and B of the examination for Associate Membership of the Institution of Civil Engineers ; or

(b) Examinations recognised by that Institution as granting practical exemption from Sections A and B.

Although these are not established posts, some have long-term possibilities. Hostel accommodation is available.

Salary range £645–£960 per annum, according to age and experience. Possibility of promotion to Main Grade. Salary range £960–£1240 per annum.

State age, nationality, details of training, experience, to W.G.10/C.W.E., Ministry of Works, Abell House, John Islip Street, S.W.1. E5302

THE ENGINEER

SEPTEMBER 18, 1953

Institution of Public Lighting Engineers

THIS week the Institution of Public Lighting Engineers is holding its annual conference in Liverpool, there being an attendance of about 1000 members and guests from this country and from several countries overseas. The conference began on Tuesday when Mr. C. C. Smith delivered his presidential address. Mr. Smith, who is the city lighting engineer of Liverpool, emphasised the importance of public lighting in its relation to road safety. He said that in the present conception of good street lighting practice, which was based almost entirely on silhouette vision, the form of road surface played an extremely important and unfortunately a capricious part. The very excellent efforts and work of the Department of Scientific and Industrial Research, through its Road Research Laboratory, must be welcomed and deeply appreciated by all having a serious interest in road lighting, but when all was said and done all they could achieve was nought if the recommendations resulting from years of careful and detailed research were ignored by those best able to implement them. Here, Mr. Smith urged, technical co-operation was required between the civil engineer and the lighting engineer. The former certainly had his problems in endeavouring to procure an economic, hard-wearing, non-skid road surface, but the function of the surface from the lighting point of view—an aspect quite neglected until comparatively recently—was rapidly becoming every bit as important as the other factors and qualities considered essential. That aspect, Mr. Smith said, should receive very much more attention than it had received and, indeed, still was receiving.

Retirement of Mr. R. A. Riddles

THE Railway Executive has announced that Mr. R. A. Riddles, C.B.E., is to retire from the railway service at the end of the present month. Since 1947, he has been the full-time member of the Executive responsible for mechanical and electrical engineering; he was formerly a vice-president of the London, Midland and Scottish Railway. Mr. Riddles began his railway career in 1909 with the former London and North-Western Railway as a premium apprentice at the Crewe works, and in the first world war he served with the Royal Engineers. He returned to Crewe in 1919 and in the succeeding years developed a progressive system of locomotive repairs which resulted in considerable economies of time and money. Mr. Riddles also had charge of the large-scale reorganisation of the Crewe Works which was undertaken in the 1920s. In 1928, Mr. Riddles was transferred to the Derby locomotive works as assistant works superintendent, and again went back to Crewe in 1931 as assistant locomotive works superintendent. He became locomotive assistant to the chief mechanical engineer, Sir William Stanier, in 1933, and two years later was promoted to the position of principal assistant. In 1937, Mr. Riddles was appointed the L.M.S. mechanical and electrical engineer for Scotland, but with the beginning of the second world war in 1939 his services were immediately made available to the Ministry of Supply to organise a directorate for the provision of transport equipment. In 1940, his directorate was enlarged to take responsibility for all Royal Engineer equipment. In addition to supervising the supply of all kinds of engines and machinery, Mr. Riddles was responsible for the design and provision of over 1000 standard "Austerity" 2–8–0 and 2–10–0 locomotives. In 1941 Mr. Riddles became Deputy Director-General, Royal Engineer Equipment, a position which he held until August, 1943, to return to the L.M.S. Railway as its chief stores superintendent. He was elected a vice-president of the L.M.S. in 1946, and in October, 1947, he was appointed as the member of the Railway Executive for mechanical and electrical engineering (including road motor engineering). Under Mr. Riddles's direction, the activities of all the locomotive and carriage works of British Railways have been co-ordinated, in addition to which he has been responsible for the design and development of twelve standard locomotives to cover all the service requirements of British Railways. Mr. Riddles, who was created C.B.E. in 1943, is a member of the council of the Institution of Mechanical Engineers, a past-president of the Junior Institution of Engineers, and a past-president of the Institution of Locomotive Engineers. At the general meeting of the last named Institution, to be held on Wednesday next, he is to receive the Gold Medal of the Institution of Locomotive Engineers for his outstanding services to the advancement of locomotive engineering.

National Coal Board Scholarships

THE National Coal Board has stated that university scholarships in mining engineering and allied subjects have been offered this year to thirty-four young men already working in the industry and to thirty-four boys from outside it. These scholarships cover the whole cost of education, and carry a maintenance allowance which may amount to £300 a year. The Board says that its faith in the scheme has been justified by the results obtained by scholarship holders who graduated this summer. Honours degrees were won by fifty-one out of the sixty-five students completing their courses. The number of awards this year to people from outside the industry is the highest since the university scholarship scheme was started six years ago, suggesting that the difficulty, experienced in the early years, of attracting to the industry applicants with sufficiently high qualifications, is being overcome. Nevertheless, the Board would like to be able to award 100 scholarships each year, since the coal mining industry's reconstruction programme has been held up partly because of the shortage of mining engineers to plan and carry through the sinking of new pits and the reorganisation of existing ones. The highest number of scholarships so far achieved is the eighty-eight awarded in 1949 when there was still a comparatively large pool of qualified men in the industry. The Board adds, however, that all the industry's future managers will not necessarily come from the universities. Part-time study by men working in the industry will still provide a large proportion and this method of working for promotion, which is traditional to coal mining, is being encouraged by the offer of paid release during working hours for study.

The Development of Guided Weapons

IT was announced in Canberra on Monday last that the Australian Prime Minister, the Minister for Supply and other members of the Australian Government concerned had had discussions with the United Kingdom Minister of Supply, Mr. Duncan Sandys, about the scheme for the development of guided weapons which is being undertaken jointly by the Governments of the two countries. They have noted with satisfaction the considerable progress already made and have discussed the programme of work to be carried out over the next few years, which includes the development of a number of weapons for the use of all the three armed Services. An official statement says that the Ministers have also reviewed the arrangements for the sharing of costs between the two Governments and have considered whether any changes were desirable in the light of experience over recent years. Up to the present, the Australian Government has borne the cost of all industrial work carried out by private firms in Australia in connection with the testing of guided weapons on the Woomera range. It has now been agreed that the United Kingdom Government will in future bear the cost of any such work which may be done to its order. On the other hand, the Australian Government has agreed to take over a greater financial responsibility for certain equipment which it has ordered for the Woomera range. The effect of these changes on the respective financial liabilities of the two Governments will depend, of course, on the amount and nature of the work being done and will therefore tend to vary from year to year. Finally, the Ministers have agreed that this important defence project should continue to be pursued in a spirit of partnership and should be accorded high priority by both Governments. Commenting on the statement, Mr. Sandys said that he had been immensely impressed by the splendid facilities provided by the Australian Government for the testing of guided rockets on the Woomera range. He said also that the intimate partnership between Australia and Great Britain, which had contributed so much to the progress achieved, was a fine example of practical co-operation between members of the British Commonwealth.

The Late Dr. B. Mouat Jones

WE have learned with regret of the death of Dr. Bernard Mouat Jones, formerly Vice-Chancellor of Leeds University, which occurred suddenly on Friday last, September 11th, at Farnham, Surrey. Dr. Mouat Jones, who was seventy, was born in London, and was educated at Dulwich College and at Balliol College, Oxford. He became a research assistant in mineralogical chemistry at the Imperial Institute in 1905, and a year later went to Lahore as Professor of Chemistry at the Government College. He returned to this country in 1913 to take up an appointment as an Assistant Professor at the Imperial College. During the first world war, Dr. Mouat Jones served with the London Scottish Regiment, and became assistant director at the G.H.Q. central laboratory. He was thrice mentioned in despatches and was awarded the D.S.O. In 1919, Dr. Mouat Jones was appointed Professor of Chemistry and Director of the Edward Davies Laboratories at the University College of Wales, Aberystwyth, where he remained for the following two years. In 1921 he became Principal of the Manchester College of Technology, an office which he relinquished in 1938 on being elected Vice-Chancellor of Leeds University. Throughout his distinguished career, Dr. Mouat Jones took an important part in the development and improvement of technical education in this country. He was a past chairman of the Association of Principals of Technical Institutions and a past-president of the Association of Technical Institutions, and during his years in Manchester served for a term as president of the Manchester literary and Philosophical Society. He was also a member of the Commission on Higher Education in West Africa, which was set up in 1944, and later served on committees on higher technological and commercial education set up by the Government in this country. Dr. Mouat Jones retired from the Vice-Chancellorship of Leeds University in 1948.

The Engineering, Marine and Welding Exhibition

No. II—(*Continued from page* 327, *Sept.* 11*th*)

YESTERDAY was the last day of the Nineteenth Engineering, Marine and Welding Exhibition at Olympia. Some of the exhibits are described in the following paragraphs.

F. Perkins, Ltd.

Twelve engines were exhibited by F. Perkins, Ltd., Peterborough—seven in the industrial and tractor section and five in the marine group. These latter engines are representative of the Perkins engine arranged for marine propulsion and all are shown with oil-operated reverse gears manufactured by Self Changing Gears, Ltd.

The display included a Mk. "S.6 M" unit, (Fig. 16), which is a four-stroke engine having six cylinders in line and an output of 100 b.h.p. at 2000 r.p.m., or 75 b.h.p. at 1500 r.p.m., the bore and stroke being 4⅜in by 5in. Nickel chrome cast iron alloy is used for the cylinder block and crankcase which form a single casting and are fitted with dry liners. A two-piece chromium iron casting forms the cylinder head, which carries the rocker gear and two overhead valves per cylinder. Aluminium alloy pistons are fitted and have three compression rings and two scraper rings, one of the latter being above and the other below the fully floating gudgeon pin. The forged nickel-chrome-molybdenum steel crankshaft is heat-treated and hardened at the bearing surfaces and is carried in copper-lead steel-back bearings.

A triple-roller chain drives the camshaft and the fuel pump shaft, the pump being of unit pattern and fitted with lift pump and pneumatic governor. High-pressure lubrication is used throughout, the oil pump being driven through spiral gears from the fuel pump drive shaft. A gear-pattern, positively driven, self-priming water pump having plastic bearings is provided, and there is a positively driven 24V dynamo, while starting is by a 24V axial starting motor. The maximum installation angle in a boat is 12 deg., which allows for a further 3 deg. of trim when the boat is under way. The diameter of the normal three-bladed propeller is 18in for direct drive and 30in with a 2 to 1 reduction gear.

Two four-cylinder and two six-cylinder Mk. "P" engines were shown, developing 27/43 b.h.p. and 43/65 b.h.p. respectively at 1200/2000 r.p.m. This model has a bore and stroke of 3½in by 5in and has a specification which is generally similar to the Mk. "S" engine. The installation angle remains at 12 deg. as before with a margin of 3 deg. for additional running trim, while the propeller diameters recommended are 15in for direct drive, 22in with 2 to 1 reduction gear and 28in with 3 to 1 reduction gear for the four-cylinder engine, the corresponding diameters for the six-cylinder engine being 18in, 25in and 32in.

In the industrial and tractor sections three-, four- and six-cylinder examples of the Mk. "P" engine were shown as adapted for various industrial purposes and having power ratings adjusted to suit the revolutions required. There was one "S. 6" bearer-mounted engine which is designed for installation in a compressor set and rated to develop 72 b.h.p. at 1400 r.p.m.

Also shown were two "L4" engines, one, illustrated in Fig. 17, designed for general industrial applications and developing 53 b.h.p. at 1800 r.p.m., and the other, developing 62 b.h.p. at 2000 r.p.m., for installation in Fordson Major tractors. The "L4" engine has a bore and stroke of 4¼in by 4⅜in, and the high-duty alloy cast iron combined cylinder block and crankcase is fitted with centrifugally cast wet liners, while the alloy cast iron cylinder head carries the rocker gear and overhead valves. The light alloy pistons have three compression and two scraper rings, and the connecting-rods, which are H-section alloy steel stampings, have steel shell big-end bearings, the upper half being lined with copper-lead and the lower half with white metal, while the small-end bushes are lead-bronze lined. An alloy steel stamping forms the crankshaft which is carried in three bearings having the upper half lined with white metal and the lower half with copper-lead.

A gear pattern pump, driven by spiral gears from the cast iron camshaft, circulates the lubricating oil and a centrifugal pump for water circulation is mounted on the front end of the engine block and is driven, with the dynamo, by a vee belt from the crankshaft. The fuel pump is flange mounted on the timing case and, together with the camshaft is gear driven from the crankshaft.

W. H. Dorman and Co., Ltd.

The range of diesel engines made by W. H. Dorman and Co., Ltd., of Stafford, covers 20 to 160 h.p. in the industrial field and 35 to 100 h.p. for marine purposes. For some time the firm has been working on the development of a new range of engines designed to give the maximum degree of interchangeability of component parts. This new range, known as the "L" series, will eventually consist of four models having two, three, four and six cylinders. They are of direct-injection, four-stroke design with cylinders having a bore of 120mm and a stroke of 130mm. A three-cylinder engine of the new design which was exhibited at Olympia is illustrated in Fig. 18.

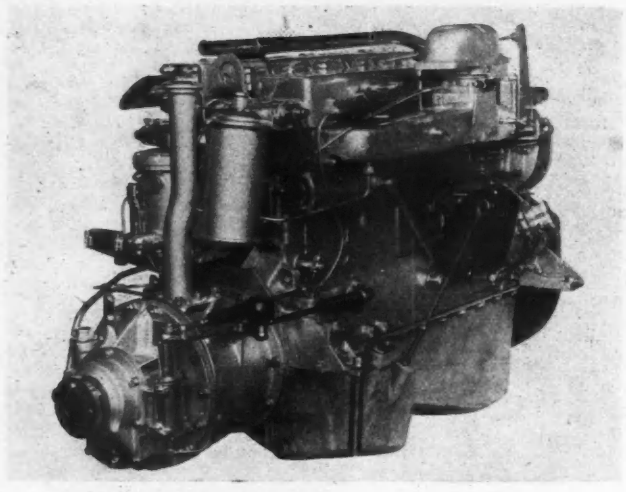

Fig. 16—"S. 6 M" Marine Diesel Engine—Perkins

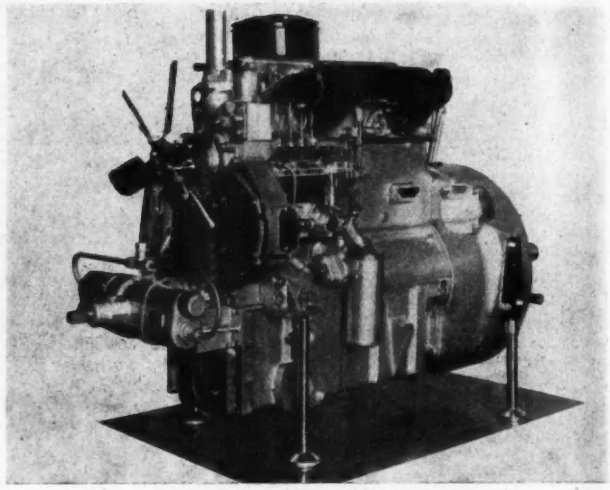

Fig. 17—"L4" Industrial Diesel Engine—Perkins

In these new engines the unified screw thread system has been adopted for screwed components and, wherever possible, the Ministry of Supply standards, such as in the cases of plain, ball and roller bearings. On all models the cast iron crankcases and cylinder blocks are of unit construction. In the two, three and four-cylinder engines the cylinders are equally spaced, but on the six-cylinder model they are equally spaced in two groups of three, with a wide centre main bearing so that the three-cylinder heads may be utilised on the six-cylinder engine.

In order to allow for servicing under a variety of operational conditions, a detachable side cover is fitted to the off side of the crankcase, which, when removed, allows access to the connecting-rods, the caps of which can be detached and withdrawn through the opening. The connecting-rod big-end is split at an angle so that after removal of the cylinder head the piston and rod assembly can be withdrawn through the cylinder bore. The main oil gallery is formed in the crankcase door, thus providing easy access for cleaning in the event of attention being necessary. Horizontal drillings from this

main oil gallery meet vertical drillings from the main bearings and camshaft.

The primary gear wheel, which fits over the crankshaft flange at the rear of the engine and forms a spigot for the flywheel, is secured in position by the flywheel bolts. This wheel meshes with a cast iron half-time wheel mounted on the end of the camshaft. Cast integral with this half-time wheel is another

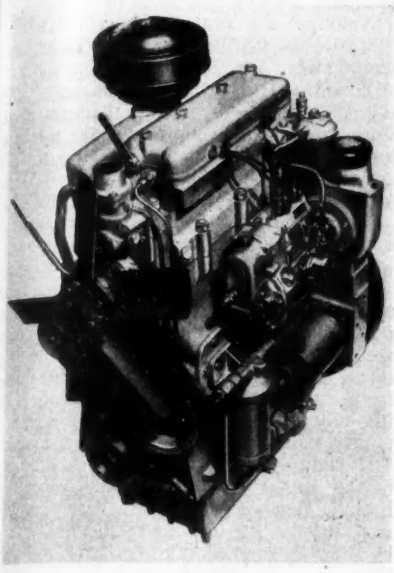

Fig. 18—Three Cylinder Diesel Engine—Dorman

gear which meshes with a steel pinion of equal diameter on the fuel pump drive. The oil pump is mounted on the rear main bearing cap and its driving pinion meshes with the primary crankshaft wheel. A spigot-mounted dynamo carries its own gear which meshes with the half-time gear. The fuel pump drive, camshaft and dynamo are situated on the near side of the engine with the fuel pump at the highest point.

The new three-cylinder engine exhibited can be arranged to develop from 21·7 b.hp. at 800 r.p.m. to 42·5 b.h.p. at 1700 r.p.m. continuously, the respective intermittent ratings being 26·5 b.h.p. and 52·0 b.h.p. The engine has a rigid cast iron crankcase and cylinder unit fitted with three wet detachable cylinder liners. A single cast iron cylinder head unit houses the overhead valves, rockers, injectors, &c., and is fitted with renewable valve seats. The crankshaft of high-duty "Meehanite" is supported in four steel-backed, copper-lead lined bearings.

A four-journal "Meehanite" camshaft mounted in the crankcase unit is provided with a renewable bearing at each end and it operates bucket design tappets which reciprocate in guides integral with the cylinder cover plate. The cylinders have one exhaust and one masked inlet valve, each fitted with two springs, and operated by pushrods and hardened overhead rockers.

In the C.A.V. fuel injection equipment each complete unit is precalibrated, the detachable nozzle holders and nozzles being precalibrated assemblies to ensure a uniform fuel supply to each cylinder. A standard C.A.V. pneumatic governor is fitted, although other types are available if specified.

The detachable sump casting of the engine holds 4 gallons of lubricating oil and is fitted with a gauze suction strainer. The oil is pumped through a full-flow filter, thence to all main and big end bearings, camshaft bearings and valve rockers by a semi-submerged, large-capacity gear pump running at engine speed. An outside adjustable relief valve is incorporated in the system, together with an oil pressure indicator. Splash lubrication is relied upon for lubricating small end bushes, cylinder walls, valve stem guides, ball bearings in auxiliary drives, and a special oil feed is provided for the cams and tappets.

Samuel Williams and Sons, Ltd.

A recording weighing apparatus for cranes which is of particular interest and is made by Samuel Williams and Sons, Ltd., Dagenham Dock, Essex, was shown upon the stand of Stothert and Pitt, Ltd. This apparatus is intended for use with a grabbing crane engaged in discharging or loading duties. With it the weight transferred in each grabbing operation is automatically and accurately recorded and the weight added to the previous total. As a full grab is being hoisted the crane driver initiates the weighing cycle by depressing a push-button in his cab. A pointer moving round a large dial indicates to the driver the total weight discharged and the figures are progressively recorded on a paper strip. Between each series of loading or unloading operations the indicating pointer can quickly be reset to zero, but the recorder figures are continuous.

The design of the apparatus is such that the same load cannot be weighed twice, as the weigher resets only when a load has been discharged. Once the taring of the grab has been effected no further adjustment to the weigher is required until a grab is changed, and a mechanism is fitted to compensate for variations of weight of rope between the load and the weighing sheaves. The makers state that the apparatus is accurate to within less than half of 1 per cent (in forty loads) which complies with the requirements of the Board of Trade.

The arrangement of a weigher equipment on a grabbing crane is shown diagrammatically in Fig. 19. The equipment consists

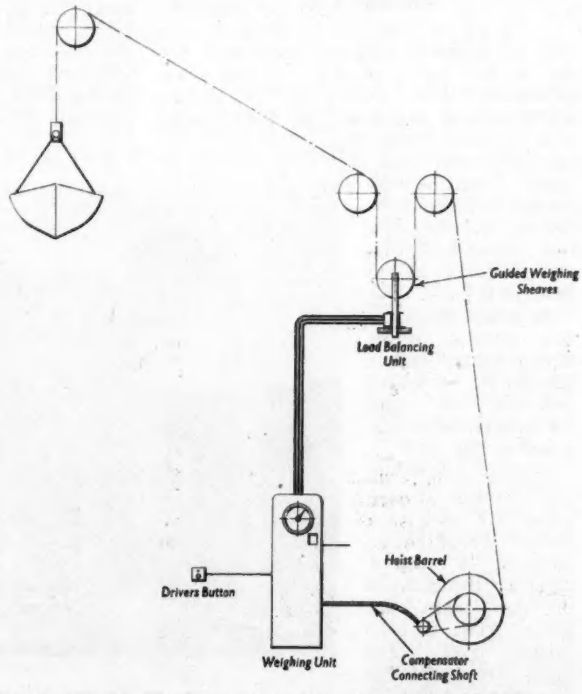

Fig. 19—Diagrammatic Arrangement of Recording Weigher—Williams

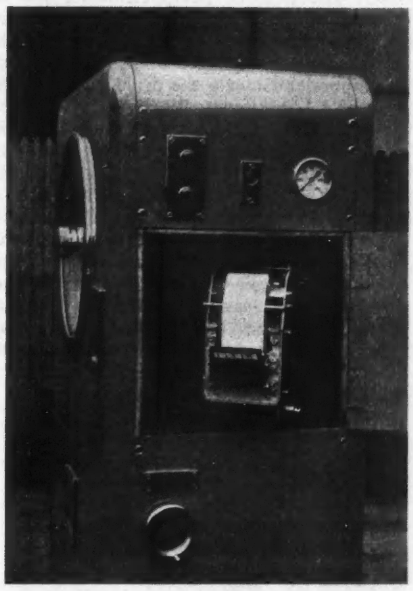

Fig. 20—Weigher Recording Unit—Williams

essentially of two units—a load balancing unit fixed to the crane structure and a weighing unit which is situated in the driver's cab. Through a suitable arrangement of sheaves, over which the grab ropes pass, the reaction from the loaded grab as it is hoisted is taken by the load balancing unit. A supported diaphragm in this unit has its position controlled by a relay valve and, through a hydraulic system, transmits pressure to the weighing unit. A spring-loaded piston in the weigher operates a gross tons pointer on a large dial when the crane driver depresses the push-button. At the same time a second pointer moving round the same dial and a counter giving the total load lifted are actuated. The counter showing the total figure is visible in a recess at the side of the indicating dial and the aggregate figure is stamped on a continuous paper strip which emerges through a slot below. The weighing unit is illustrated in Fig. 20 with the side door open to show the counter mechanism.

By means of a small handwheel at the side of the weigher the unit is tared to the weight of the empty grab before operations start. Adjustment of the weighing mechanism for variations in the weight of crane rope as grabbing proceeds is effected by a drive transmitted through a flexible shaft from the main hoisting gear of the crane to a compensating mechanism in the weigher. Pressure fluid for the hydraulic system is supplied by a motor driven pump in the base of the weigher unit.

Sir George Godfrey and Partners, Ltd.

A selection of Roots blowers, vacuum pumps, gas boosters, superchargers, and a diaphragm pump were shown by Sir George Godfrey and Partners, Ltd. The diaphragm pump can deliver oil free air

at pressures up to 36 lb per square inch and flows up to 1·5 cubic feet per minute. It is mounted on a base-plate and can be either directly driven or belt driven by a fractional horsepower motor.

The pump, seen in Fig. 21, consists of a cast light-alloy body, of rectangular section, having mounting feet and a cover incorporating a breather fitted to the top. Four mounting faces are provided, two for drive covers and two for pump elements, and if required an additional pump element can be mounted instead of the top cover. Each drive cover has a flanged bush, which serves to support and locate the drive shaft, and a rubber seal is fitted to prevent oil leakage. The shaft incorporates a single cam which bears on the ends of the pump plungers. On opposite sides of the drive casing are two pump elements, each consisting of a light alloy body, a cover plate and a rubber-impregnated diaphragm which is sandwiched between body and cover, and to which is secured a plunger spring-loaded on to the drive shaft cam and supported in a plain bearing, in the body. One outlet and two inlet automatic, spring-loaded, disc

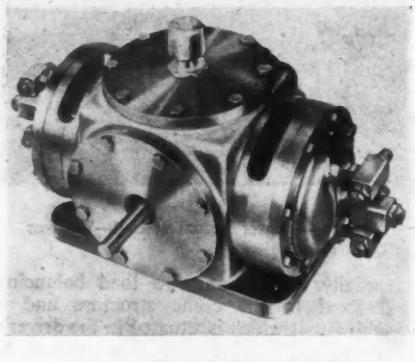

Fig. 21—Diaphragm Pump—Godfrey

valves are mounted on the element cover, while a rubber seal prevents oil from leaking into the inner chamber of the pump element. The inside of the body is used as an oil sump and, when the drive shaft rotates, an oil slinger plate generates an oil mist which lubricates the cam, plunger bearings and drive shaft bushes.

When in operation the cam on the drive shaft forces the pump element plunger outwards against the spring pressure, causing the diaphragm to expel air through the outlet valve, the inlet valves remaining closed. As the shaft rotates the spring-loaded plunger causes it to follow the cam contour and the diaphragm is pulled inwards, resulting in the exhaust valve closing and the inlet valves opening to allow a fresh charge of air to be drawn into the pump chamber.

K. W. Chemicals, Ltd.

The exhibits on the stand of C. S. Milne and Co., Ltd., of Deptford, included a portable oxygen generator now being imported into this country by K. W. Chemicals, Ltd., of 36, Kingsway, London, W.C.2. This generator (see Fig. 22) is of simple design and construction and is intended for the generation of oxygen on sites where normal supplies are difficult to obtain. In it the oxygen is produced by the heating of chemical "candles" in a retort and gas of 99·5 per cent purity is stated to be generated.

The generator incorporates a tank for oxygen storage fitted with the usual control and regulating devices, with a scrubbing

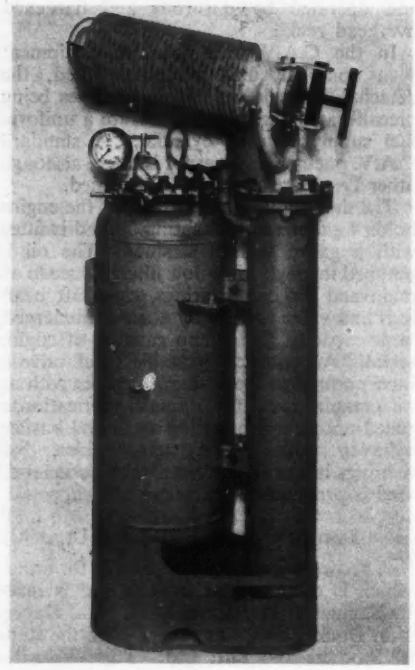

Fig. 22—Portable Oxygen Generator—K. W. Chemicals

container filled with purifying solution at the side. At the upper end of the scrubbing container is a steel retort fitted with cooling ribs in which the candles are heated. Candles are introduced into the retort through a charging cover at one end fitted with a quick-action clamp. The normal charge of four candles is exhausted in about fifteen minutes and produces about 1 cubic metre of oxygen at a pressure of about 14kg per square centimetre in the tank. A check valve fitted to the scrubber prevents the gas getting back into the retort during the recharging operation if the tank is not empty.

The complete apparatus weighs some 265 lb and the candles are supplied in drums each of which holds forty candles, sufficient to produce some 10 cubic metres of oxygen.

Whessoe, Ltd.

A variety of plant and equipment is built by Whessoe, Ltd., of Darlington, for the oil, fuel gas, steel, chemical and other industries. One section of this firm's stand showed by means of photographs and models representative steel structures manufactured for the petroleum industry, including the first British-built catalytic cracker at the Stanlow refinery.

A model shows the two elevated petrol storage tanks, built at Hamble for Shell-Mex and B.P., Ltd., and the installation is illustrated in Fig. 23.

In this installation two 200-ton storage tanks are each supported on four tubular columns in such a way that the bottoms of the tanks are 24ft. 6in. above ground level. The tanks are each 26ft diameter by 12ft on the vertical barrel, with elliptical tops and bottoms. Access to all fittings on the tanks is provided by an inclined staircase to a landing platform, from which a spiral staircase provides access to the top.

Evaporation loss from the tanks was minimised by working them at pressure, and this eliminated not only the thermal breathe, but also a large percentage of the filling losses generally associated with the pumping in and emptying of the petrol.

Amongst the heat exchangers exhibited there was a floating head unit which was sectionalised to show details of its construction. This unit contains some 248 tubes, ¾in O.D., in a 20in diameter shell. For convenience the tube length has been limited to 6ft, although lengths up to 20ft are commonly employed in practice. There are two tube-side passes and one shell-side pass containing equally spaced segmental baffles for promoting cross flow of the shell-side fluid.

The cut-away portion is at the floating head end and the flanged shell cover is removed to reveal the floating tube sheet, floating tube sheet cover and backing ring. The floating tube sheet, cover and backing ring are further cut away to reveal the grooves in the tube holes which assist in making a tighter expansion of the tubes in the sheet. The floating head support baffle and segmental baffles are also shown. When the backing ring and cover have been removed from the floating tube sheet, the whole tube bundle can then be withdrawn from the shell from the fixed tube sheet end.

This design of heat exchanger is employed when the shell-side fluid is fouling, as its arrangement allows the whole tube bundle to be removed for cleaning the external surfaces of the tubes. As the bundle "floats" in the shell, temperature stresses resulting from the differential expansion between shell and bundle are eliminated.

Another section of the stand was used to illustrate methods which the company advocates for the reduction of volatile spirit loss in storage.

Forms of storage tank construction shown include Horton floating roofs, "Horton-domes," Horton "Vaporspheres" and spherical storage vessels. A range of special tank fittings, designed to render inflammable liquids safer in storage, included the latest Shand and Jurs relief valve and automatic tank gauges for the accurate measurement of liquid levels by readings at tank side or pump-house.

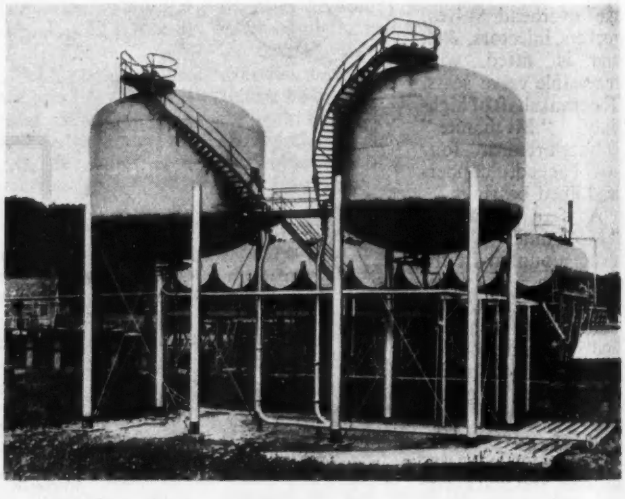

Fig. 23—Elevated Storage Tanks—Whessoe

Asea Electric, Ltd.

An automatic arc welding machine (Fig. 24), designed for operating with standard coated electrodes 18in long, was one of the exhibits demonstrated by ASEA Electric, Ltd., Fulbourne Road, Walthamstow, London, E.17.

This machine can be used for welding with either alternating or direct current and it is arranged for travel on the workpiece or on a separate track depending on local requirements and the disposition of the work. The welding head can be mounted in either of two ways: it can be fixed to the travel carriage or it can be supported by self-adjusting brackets, allowing the head to be moved both laterally and vertically in relation to the carriage.

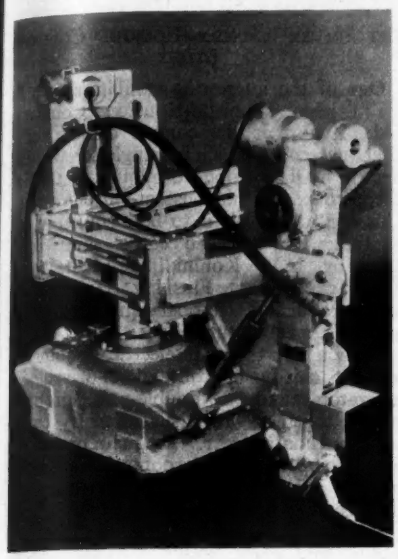

Fig. 24—Automatic Arc Welding Machine—ASEA

This machine can be used for welding downhand only. Chamfered as well as unchamfered joints and fillet welds can be executed.

The Bergius Company, Ltd.

The Bergius Company, Ltd., Dobbie's Loan, Glasgow, the builder of the Kelvin marine engines, showed three of these engines as representative of the range manufactured on the stand of Associated British Engineering, Ltd. The smallest engine on view was the Kelvin-Ricardo model "E4," which is a petrol-paraffin engine developing 15 b.h.p. at 1150 r.p.m. at continuous rating. This four-cylinder model has a bore and stroke of 3in by 4½in, a compression ranging between 70 lb to 110 lb per square inch, and a b.m.e.p. of 93 lb per square inch as a petrol engine, and 81 lb per square inch when using paraffin as fuel. There are two cylinders to a block and the pistons are fitted with three parallel cast iron compression rings, all fitted above the gudgeon pin. The engine is generally of cast iron and the high-tensile steel crankshaft is carried in three split white metal bearings, while the camshaft has split bronze bearings.

A three-cylinder, model "J," four-cycle, solid-injection diesel engine having a continuous rating of 33 b.h.p. at 1000 r.p.m. and a bore and stroke of 4½in by 6⅜in was shown. The cylinders, which have detachable heads and renewable valve guides, are monobloc castings fitted with hardened dry liners, and the pistons have four double tapered compression rings. The third exhibit which we illustrate in Fig. 25, is the largest unit built by the company; it is a six-cylinder Mk. KR engine, which has a bore and stroke of 6in by 9in and a continuous rating of 132 b.h.p. at 750 r.p.m. Hardened dry liners are fitted and the aluminium alloy pistons have three double tapered compression rings and one oil control ring, all fitted above the gudgeon pin. The engine, which has Ricardo-Comet combustion heads, is mainly of cast iron and has a compression pressure of 570 lb per square inch. Copper-lead-bronze, steel-backed bearings carry the 3 per cent nickel steel heat-treated crankshaft, while the connecting-rods are carbon steel stampings.

Petrol or petrol-electric starting is provided and the engine, which is governor controlled, and has a speed range from 160 to 750 r.p.m., drives the propeller through a 2 to 1 reverse reduction gear which is attached direct to the engine. C.A.V. fuel pumps are fitted, together with a feed pump when this is required, and the lubrication is automatic, the lubricating oil being supplied by a ram pump. The crankcase, which is in one piece, is fitted with inspection doors of a size sufficient to allow for the removal of pistons and connecting-rods and the adjustment of bearings.

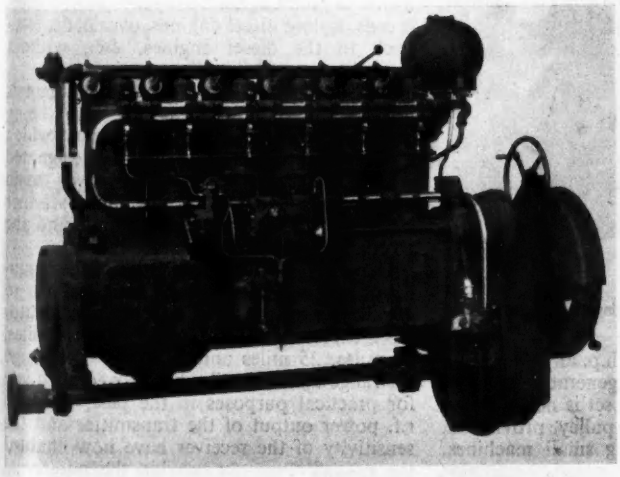

Fig. 25—132 B.H.P. Kelvin Diesel Engine—Bergius

Newton Victor, Ltd.

A new industrial X-ray equipment, shown by Newton Victor, Ltd., 15, Cavendish Place, London, W.1, is designed for operation at voltages up to 150 kVp and currents up to 10mA, and is suitable for the examination of welded steel joints up to 1½in thick on open construction sites and, particularly, on pipelines.

In this equipment, which is known as the "Raymax 150," the high-voltage transformer and the associated X-ray tube filament transformer are both housed in a cylindrical steel tank or "tubehead" of only 16in overall diameter. The X-ray tube is directly connected to the high-voltage transformer in the tank, but the tube target is located at the extremity of a small diameter extension tube projecting 18½in from the main tank. The reduced overall dimensions of this complete tubehead are the result of using sulphurhexafluoride gas for the insulation of both the transformer and the X-ray tube. It is possible to insert the target extension tube into hollow castings and to draw the complete tubehead through pipes of 18in and upwards diameter.

The controls for the "Raymax 150" unit are housed in a robust metal box for convenient transportation. They include a short-range auto-transformer for the compensation of mains supplies of varying voltage, a stepless auto-transformer for control of voltage, with an indicating instrument calibrated in kilovolts, a milliammeter and rheostat for regulation of the tube current, and an exposure-timer with a range of 0–55 minutes in intervals of one second, together with the usual switches and indicating lamps.

For use in fixed installations a gantry support is provided for the tube head. It is designed to facilitate ample vertical and horizontal movements so that the X-ray target can be easily and rapidly positioned in relation to the specimen. It is a simple operation to remove the tubehead from the gantry when required.

Fig. 26—Control Desk for "Raymax 250" X-Ray Equipment—Newton Victor

As shown by another exhibit, the control and switchgear for the "Raymax 250" industrial X-ray generator, which operates at 10mA and at voltages up to 250kVp, is now incorporated in a more convenient and compact control desk (Fig. 26), measuring 27in wide by 24in deep by 50in high. Mains electric current is fed to a short-range, continuously variable auto-transformer so that the supply to the generator can be kept constant for mains voltages between 190V and 290V. Stepless voltage control likewise assists in choosing, and maintaining during exposure, the desired voltage across the X-ray tube. Appropriate indicating instruments are associated with both controls. A milliammeter and rheostat provide for adjustment of the tube current, while a constant voltage transformer stabilises it at any preset value. A very accurate time relay, graduated in intervals of one second up to fifty-five minutes, terminates radio-

graphic exposures at the pre-determined time. The inverse voltage across the X-ray tube during the unloaded half-cycle is reduced to the same value as that during the loaded half-cycle by a long-life metal rectifier in the primary circuit, shunted by a resistance. Momentary contact push buttons and contactors, together with indicating lamps, are used to switch both the mains supply and the high-voltage transformer. The control desk is finished in two shades of grey enamel.

G. E. Simm (Engineering), Ltd.

A useful device suitable for a wide variety of pulling and lifting jobs was shown by G. E. Simm (Engineering), Ltd., East Parade Chambers, Sheffield, 1. This device is made in various capacities and the largest, which weighs only 40 lb, is capable of hauling or hoisting loads of up to 3300 lb. A wire rope fitted with a hook is used in conjunction with the device. This rope is first threaded through the body of the device and then drawn through to move or hoist the load by operation of a hand lever.

The mechanism of this "Tirfor" pulling and lifting machine can be seen in the photograph of a unit, with one side plate removed, which we reproduce in Fig. 27. The rope is threaded between cams forming two sets of split jaws spaced apart and actuated by a crank and lever arrangement. Backwards and forwards movement of the handle operates the crank which imparts through the levers

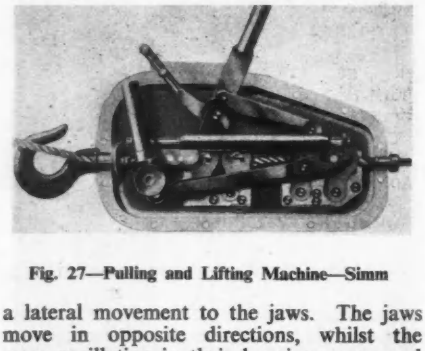

Fig. 27—Pulling and Lifting Machine—Simm

a lateral movement to the jaws. The jaws move in opposite directions, whilst the cams oscillating in their housings open and close alternately on the rope. Movement of the crank in one direction causes one set of jaws to grip the rope and pull it through the machine, whilst the other set moves freely along the rope in the opposite direction. On the reverse movement of the crank the second set of jaws grip the rope to draw it along, whilst the grip of the first set of jaws is released and their return movement begins with the rope passing freely through. One forwards and backwards movement of the operating handle gives a rope travel of some 3in.

A reversing lever projecting from the top of the machine causes the jaws to move in opposite directions and permits the controlled lowering of loads. A release catch is fitted to hold both sets of jaws open whilst the rope is being threaded into the machine.

The Quasi Arc Company, Ltd.

One of the new developments demonstrated by the Quasi Arc Company, Ltd., Bilston, Staffs, was the "MR375" metal rectifier arc welding set which is designed to take a balanced three-phase load with stepless remote control of the full welding current range by means of a single control knob. With this provision the welding operator has full current adjustment at the point of welding. The set is fan cooled and is intended to supply a maximum welding current of 375A at 30 arc volts on a 50 per

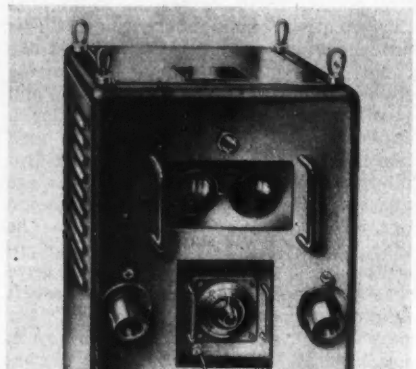

Fig. 28—Metal Rectifier Welding Set—Quasi-Arc

cent duty cycle. It is suitable for applications in which d.c. welding is preferred; for example, the welding of non-ferrous metals and alloys, stainless steels and heat-resisting steels.

The equipment (Fig. 28) consists of a welding transformer, regulator and selenium plate metal rectifier enclosed in a sheet steel cabinet with ventilating louvres and a motor-driven cooling fan. Remote control over the full current range of the set is effected by a small rheostat which is normally housed in a recess in the front panel of the set, but which can, if required, be operated from the welding station. The cabinet is mounted on two steel skids and is fitted with four eye bolts. The overall dimensions are approximately 36in by 22in by 37in high, and the weight is about 7½ cwt.

To meet the demand, particularly in agricultural areas, for a small and economical diesel engine welding set, the company has introduced the "DE/180" single-operator equipment. This set, as exhibited (Fig. 29), consists of a Petter "AVA2 Series II"

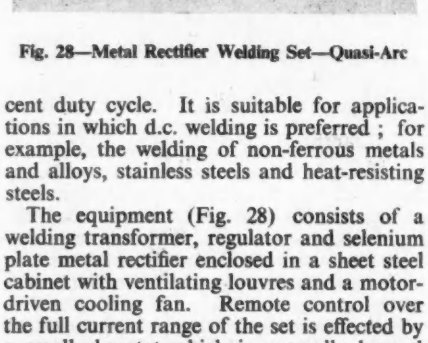

Fig. 29—Small Engine Welding Set—Quasi-Arc

engine, which develops 11 h.p. at 1650 r.p.m., and drives the welding generator through four vee belts. When the set is not required for welding, the engine pulley provides a power take-off for driving small machines. Mounted on the generator frame is a regulator which gives stepless variation of output current from 25A to 180A. The engine and generator are bolted to a channel iron base which is normally supplied with four hard steel floor locating pins, but André rubber mountings can be fitted, if required.

Among the new electrodes shown on the same stand were a touch welding electrode intended particularly for welding vertically downwards, electrodes for hard facing, electrodes for welding chrome-nickel steels, and low-hydrogen electrodes giving high impact values at low temperatures.

The British Thomson-Houston Company, Ltd.

One of the interesting exhibits shown by the British Thomson-Houston Company, Ltd., Rugby, is the control cubicle for a direct-current 7000 s.h.p., single-screw diesel electric marine propulsion equipment which is controlled on the constant-current system. This control cubicle is to be installed in one of three diesel-electric cargo ships being built by N.V. Koninklijke Maatschappy "De Schelde" at Flushing, Holland, the main propulsion electrical equipments being of B.T.H. manufacture.

In each ship the main electrical equipment consists chiefly of four diesel-driven d.c. generators and a double-unit propeller motor, together with their auxiliary equipment and control gear. The main propulsion system is operated on the controlled constant-current principle: there are two main circuits, each consisting of two of the generators and one-half of the propeller motor, and each circuit is controlled by means of "Amplidynes" acting as exciters for the various generator and motor fields. Control of the propeller motor torque (and hence the speed) is effected by means of potentiometer rheostats in the reference fields of the generator "Amplidyne" exciters and the motor "Amplidyne" exciters. As these fields require comparatively low power the potentiometers, which can be operated from control stations either on the bridge or in the engine-room, are very small. The "Amplidynes" are used to control the strengths of the propeller motor fields and the current in the main circuits to give the most economical operating conditions.

Included in the equipment are the main generator control switchboards containing the isolating and set-up switches which are interlocked with the field switches, an excitation panel carrying the exciter selecter switches, the bridge engine-room control change-over switch, and instruments and protective devices. Full advantage has been taken of the flexibility of "Amplidyne"-controlled circuits to include protective arrangements to guard against propeller motor overspeeds, failing diesel engines, overloads, feedback to the diesel engines, &c., without removing the main circuit power.

Recent developments in the company's marine radar equipment are also being shown. The complete equipment, which is displayed as a working exhibit, is designated "RMS2," and consists of five main assemblies, namely, transceiver unit, scanner assembly, power unit, display unit, and the motor alternator set and starter.

One of the new characteristics of the equipment is that an additional range of up to 40 miles is now provided, so that the navigator has a choice of five scales—16 cables 4 miles, 10 miles, 25 miles and 40 miles. Although the range up to 25 miles has proved adequate for practical purposes in the past, the high r.f. power output of the transmitter and the sensitivity of the receiver have now enabled the manufacturer to provide the additional long-range scale (40 miles) which is useful

for position fixing and giving earlier warning of landfall or of rainstorms, &c.

Another recent development is the introduction of a "fast time-constant" circuit as a means to reduce the effect of "clutter echoes" from rain, snow, sand particles, &c., which can be so obtrusive as to obscure the echoes from land, buoys, or other shipping, thus blanking out important information. By operating the "Differentiator" push-button control on the display unit, only the nearer edge of an echo of long duration is passed to the P.P.I. and solid targets within the clutter area will be visible on the screen, provided that they are stronger than the clutter echoes.

For coastwise navigation a new device is fitted on the display console for the measurement of drift; the arrangement is extremely simple and allows drift measurement to be made directly with speed and accuracy. It consists of a quadrant scribed on the amber "Perspex" filter (mounted directly above the face of the P.P.I. tube) diametrically opposite the existing radial bearing line, the quadrant having two sets of five parallel lines at right angles. The lines are spaced so that the sides of the squares thus formed represent one-fifth of the range scale in use. To measure drift, the bearing cursor is rotated so that the latticed quadrant (or graticule) covers the display between 0 deg. and 90 deg. either on the port or starboard bow, so that a selected fixed target appears on the P.P.I. in the latticed area. Drift can then be measured directly by means of the variable range marker adjusted from time to time to measure the perpendicular distance to the target from the ship's course. When the equipment is in normal operation, the graticule covers the aft and least important portion of the display, causing no obscuration on bearings between 0 deg. and 135 deg. port and starboard.

The National Gas and Oil Engine Company, Ltd.

Three diesel engines formed the main exhibit of the National Gas and Oil Engine Company, Ltd., Ashton-under-Lyne, on the stand of Associated British Oil Engines, Ltd. There was a marine unit, Mk. R4A6, which is a six-cylinder engine having a rated output of 300 b.h.p. at 600 r.p.m. and is directly coupled to a Brush d.c. single-bearing compound-wound generator of 175kW and 220V. Another diesel alternator set was shown, and this was a flange-mounted, 50 c/s, three-phase, Brush alternator of 208kW and 400/440V, driven by a "M4AU8" pressure-charged, four-stroke, compression-ignition, direct-injection engine developing 306 b.h.p. at 1000 r.p.m., and having eight cylinders in line and a bore of 6in by a stroke of 8½in.

The main exhibit was a "F4AM8" eight-cylinder, four-stroke, compression-ignition, solid-injection marine engine developing 760 b.h.p. at 500 r.p.m. and driving through an oil-operated reverse reduction gearbox with a ratio of 2 to 1, to deliver 714 s.h.p. at the propeller shaft. This engine has a bore and stroke of 12in by 15in respectively, a b.m.e.p. of 89 lb per square inch, and a full-load consumption of 0·36 lb per brake horsepower per hour. Both the bed-plate and column are one-piece castings and the four-valve cylinder heads are of high-duty cast iron. Each piston has four pressure rings and two scraper rings and the connecting-rods, which are H-section stampings of alloy steel, have a phosphor-bronze bush at the small end and white-metalled big end bearing. The crankshaft is machined from a solid forging of Siemens Martin acidic mild steel and is carried in shell bearings lined with white metal.

The valve spindles are of heat-resisting steel and the exhaust faces are Stellited and the camshaft, which has hardened steel cams, is gear driven from the crankshaft. There are separate fuel pumps for each cylinder and the engine speed is controlled by a centrifugal governor. A gear pump supplies lubricating oil at 20 lb to 25 lb per square inch and starting is by compressed air.

Also shown on the stand was a model of the engine-room of a whale catcher which is being built by A. and J. Inglis for United Whalers, Ltd. The main and auxiliary machinery consists of "National" engines, the main propulsion units being two Mk. B4AUM6 engines, each capable of developing 1600 b.h.p. at 350 r.p.m. They drive a direct reduction 2 : 1 gear unit through electric slip couplings, which delivers 2720 s.h.p. at 175 r.p.m. to a "Kamewa" variable-pitch propeller made by J. Stone and Co., Ltd.

(To be continued)

A Short History of Spectroscopy

By T. W. CHALMERS, D.Sc., M.I.Mech.E.

No. VII—SELECTIVE REFLECTION

(Continued from page 329, Sept. 11th)

THE table given in the previous article shows that the extent to which the total spectrum can be explored by means of refracting prisms is restricted by the limited transparency of available prism materials. The bounds are set at a wavelength of about 0·12 micron in the ultra-violet—the lower limit of fluorite transparency—and at a wavelength of about 28 microns—the upper limit of the transparency of potassium bromide.

Lack of transparency naturally also restricts the use of transmission gratings. In addition, most of the materials mentioned in the table do not lend themselves to the fine ruling involved in making a grating. In practice the only material wholly suitable for the production of a transmission grating is glass.

A wire grating is affected by the transparency of the air which surrounds it and fills the openings between the wires. This restriction can be overcome by operating the grating in a vacuum since a perfect vacuum is perfectly transparent to light radiation of all wavelengths. This procedure is, however, itself subject to a restriction. It is an essential requirement in all forms of grating that the spacing between the lines should be comparable with—not necessarily equal to—the wavelength of the radiation being studied. From the manner in which a wire grating is made it is hardly possible to conceive how one with more than two or three hundred wires to the inch could be produced. A ruled grating, on the other hand, may have upwards of 20,000 lines to the inch.

This consideration clearly debars the use of a wire grating as a means of studying the short waves towards and beyond the violet end of the visible spectrum. A wire grating can, however, be used effectively for studying the much longer infra-red rays. For example, a grating with only 120 lines or wires per inch is suitable for wavelengths of 70 to 140 microns. The wire grating is therefore restricted to the study of the far infra-red region.

The reflection grating has now to be considered. Such a grating, operating by the reflection of light radiation from, and not by its transmission through, the material on which the lines are ruled, is independent of any limitations to the transparency of the material.

It might therefore appear that a reflection grating—operated in a vacuum to avoid any lack of full transparency of air—provides a method *de luxe* for the study of spectra. An important question, however, at once arises. Is the reflectivity of a metallic or other surface in any way dependent upon the wavelength of the incident radiation? The investigation of this subject proved very fruitful. It provided spectroscopists with a means of studying the infra-red region considerably beyond the wavelength marking the upper transparency limit of potassium bromide, the point which, at one time, seemed to set a bound to further progress.

When light radiation falls on any substance the flux of energy which it represents will in general be dispersed in three different ways. Part of it will be transmitted through the substance, part will be reflected back from it, and part, entering the substance, will be absorbed therein.

On this basis an opaque substance is one in which the incident radiation is dispersed in some ratio between reflection and absorption, none of it being transmitted. Most metals, in the range of the visible spectrum, absorb the wavelengths in the same relative proportion. As a result, the reflected light is of the same relative composition as the incident light. In other words, they exhibit "non-selective reflection."

Copper and gold are two exceptions. These metals absorb a larger proportion of the wavelengths towards the violet end of the spectrum than they do of those towards the red end. As a consequence, the light reflected from them contains a bigger proportion of the red wavelengths than the incident light. They are therefore said to show "selective reflection" in favour of the wavelengths towards the red end of the spectrum. This selective reflection of copper and gold is made manifest by the deepening of their colour when light is reflected in succession from pieces of them arranged in a re-entrant manner.

It is thus obvious that if a reflection grating is to give an uncontaminated spectrum of the incident light it must be made of a metal which is non-selective to all the wavelengths present in the light. In the visible region "white" metals, such as speculum, silver and aluminium, are suitable, but "coloured" metals, such as gold and copper, would be unsuitable.

All crystalline substances, transparent to visible light, are opaque to infra-red radiation. In a number of instances their opacity as the wavelength increases disappears or diminishes and they again become transparent or, at least, partially so. This curious characteristic may be repeated more than once—that is to say, as the wavelength increases a crystalline substance may exhibit alternating bands of transparency and opacity.

Glass, although it is not crystalline, may show this kind of behaviour. For example, Fig. 24 *ante*, indicates that the particular glass to which the curve relates is opaque to infra-red radiation of wavelengths between about 1 and 1·5 microns. Thereafter it has a low degree of transparency which

still later—at about 2·5 microns—again gives place to opacity. Quartz is even more striking in this respect. It ceases to be transparent to infra-red radiation of about 4·5 microns wavelength. The ensuing band of opacity extends to about 50 or 70 microns, at which point and beyond it again becomes transparent to a certain extent.

Within the opaque region of glass or quartz, or any other substance which similarly develops opacity as the wavelength increases, the radiation incident on the substance must be dispersed entirely by reflection and absorption. In the visible region the substance would be described as a transparent body, but in the subsequent opaque region it assumes towards incident radiation the characteristic of a metal. The question at once arises : does a crystalline substance in this metallic or opaque region act towards the incident radiation like speculum metal, silver or aluminium, or does it show selective reflection like gold and copper ?

In 1896 E. F. Nichols made a remarkable discovery in this field. Studying the behaviour of quartz within its region of opacity, he found that at a wavelength of 7·4 microns it showed little or no reflection of infra-red radiation. At this wavelength therefore, the radiation was being entirely or predominantly absorbed. At a wavelength of 8·4 microns, however, a remarkable change occurred. The quartz almost suddenly developed a high degree of reflectivity, as high, it was reported, as that of burnished

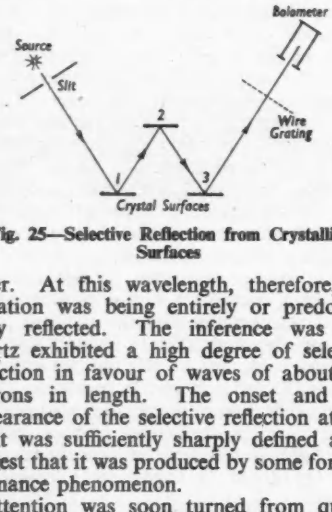

Fig. 25—Selective Reflection from Crystalline Surfaces

silver. At this wavelength, therefore, the radiation was being entirely or predominantly reflected. The inference was that quartz exhibited a high degree of selective reflection in favour of waves of about 8·4 microns in length. The onset and disappearance of the selective reflection at this point was sufficiently sharply defined as to suggest that it was produced by some form of resonance phenomenon.

Attention was soon turned from quartz to other crystalline substances, which were transparent to visible light and opaque to longer wavelengths, with the object of discovering whether and if so at what point in the infra-red they exhibited selective reflection. The general method of experiment is indicated in Fig. 25. Radiation from a source was reflected back and forth between several plane surfaces of the crystalline substance, the final reflection being received on a thermopile or bolometer. If the substance exhibited selective reflection at some particular wavelength—or narrow band of wavelengths—the successive reflections would increasingly isolate it and eliminate the influence on the bolometer of wavelengths above and below that at which the selective reflection occurred.

The source may contain waves of all lengths from the shortest in the ultra-violet to the longest in the far infra-red. The rays at the lower end are, however, within the transparency region of the first crystal surface. They, therefore, pass through it and do not reach the bolometer. Beyond the upper transparency limit of the substance come the wavelengths to which it is opaque. These rays are either absorbed—in which case they do not reach the bolometer—or are reflected—in which case they pass onwards. With increasing wavelength the absorption increases and the reflection decreases. Then comes the wavelength—or narrow band of wavelengths—corresponding to selective reflection. At this point absorption practically ceases and the waves are almost wholly reflected. Above this point the reflection disappears and absorption again occurs.

It follows, therefore, that if a wire grating is interposed in front of the bolometer the thermal " spectrum " produced will cause the bolometer to give a sharp maximum reading at one point, corresponding to the wavelength at which selective reflection occurs. On each side of this point the bolometer will give little or no reading. In this way the occurence of selective reflection can be detected and the wavelengths at which it occurs measured.

The rays which are selectively reflected are called the residual rays or *reststrahlen*. The description of them as " residual " is justified by the fact that they are the residue of all the wavelengths present in the source after they have been subjected to the equivalent of a filtering process. The first stage of filtering is performed by the transparency of the crystalline substance and the second by its absorptive capacity. Selective reflection provides the equivalent of a third—selective filtering—stage.

During and after 1897 the selective reflection shown by many crystalline substances was actively studied, principally by Rubens and Nichols. Rock salt, the upper transparency limit of which is about 15 microns, was found to exhibit selective reflection at about 52 microns. Sylvite (potassium bromide), opaque at about 23 microns, showed selective reflection at just over 63 microns. Potassium bromide, the most transparent material available for making prisms, was found to exhibit selective reflection at about 83 microns.

Salts of the element thallium carried the story still further. The chloride showed selective reflection at 92 microns, the bromide at 117 microns, and the iodide at about 152 microns. It is of interest to note that thallium, an element closely related to lead, was discovered by Crookes in 1861 by the method of spectrum analysis. It has repaid its debt to spectroscopy by its own contribution to the advancement of the science.

The phenomenon of selective reflection enabled the study of the infra-red region to be extended from about 28 microns, the limit of transparency of potassium bromide, to as far as about 152 microns, the wavelength at which thallium iodide exhibits selective reflection. For some time further progress was halted. Thallium iodide is not necessarily the material which shows selective reflection at a higher wavelength than any other. The difficulty in the way of pushing beyond the limit which it set lay in the small proportion of the energy in the source which survived the filtering process and remained to be detected in the residual rays. As the wavelength at which selective reflection occurred increased, the energy which the residual rays presented to the bolometer for detection became less and less.

Spectroscopists were naturally not content to believe that 152 microns marked the limit of the infra-red spectrum. The search for still longer waves was not abandoned. In 1911 Rubens and Wood developed a method of using quartz lenses which led the search successfully onwards.

The optical properties of quartz, although not unique, are in kind and degree such as to give it exceptional interest. Here, however, we need only consider the particular property of which Rubens and Wood took advantage, namely, the fact that quartz, after becoming opaque at about 4·5 microns, again becomes transparent to wavelengths above 50 microns or 70 microns.

A diagram of the experimental equipment used by Rubens and Wood is given in Fig. 26. Two quartz lenses L_1 and L_2 were interposed between a source of radiation S—actually a Welsbach incandescent mantle—and a thermopile T. Three opaque screens D also formed part of the arrangement, two at the centres of the lenses and one, with an aperture in it, midway between them. Radiation lying in the opaque region from 4·5 microns to about 70 microns would be stopped by the quartz lenses. In the transparent region below 4·5 microns some of the radiation, falling on the centres of the lenses, might pass through the aperture and reach the thermopile were it not for the opaque screens at the lens centres. Other short-wave radiation falling on the lens L_1 outside the protected centre would pass through the lens, but would be intercepted by the intermediate screen D. Radiation of long wavelength, at or above 70 microns, would pass through the lens L_1. Focused on the aperture, it would emerge divergently therefrom and, falling on L_2, would finally be focused on the thermopile. The important fact to notice is that the index of refraction of quartz for long waves is considerably greater than the index

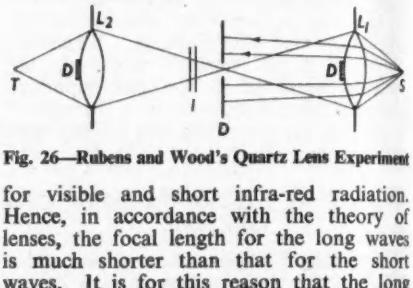

Fig. 26—Rubens and Wood's Quartz Lens Experiment

for visible and short infra-red radiation. Hence, in accordance with the theory of lenses, the focal length for the long waves is much shorter than that for the short waves. It is for this reason that the long waves can be focused on the aperture while the short waves are not so focused and, falling on the intermediate screen, are intercepted.

The arrangement therefore succeeded in isolating the long waves present in the source. The length of the isolated waves was determined by an interferometer placed at I. It was found that the radiation from a Welsbach mantle contained waves up to and over 150 microns in length.

Later Rubens and von Bayer used the same method to study the waves emitted by a quartz mercury vapour lamp. They found wavelengths ranging up to 300 microns or more—or about $\frac{1}{3}$mm. This figure is still approximately the longest wavelength detected in the infra-red by optical methods.

In 1888 Hertz's historic achievement consisted of the discovery of electric waves of about 1m or 2m in length. In succeeding years others detected electric waves of ever shortening length. By 1911 the shortest found was 2mm and in 1923 a wavelength of $\frac{1}{6}$mm was attained.

In this manner the gap between the longest infra-red wavelength and the shortest " wireless " waves was steadily narrowed until it disappeared and finally overlapped. In other words, not only is there continuity between heat and " wireless " waves ; there is actually a narrow band of wavelengths which may be produced thermally and detected optically or alternatively be generated and measured electrically.

(To be continued)

The Third European Machine Tool Exhibition

No. I

THE third European Machine Tool Exhibition organised by the European Committee for the Co-operation of Machine Tool Industries was held this year at the Palais du Centenaire, Brussels, from September 4th to September 13th. More than seven hundred exhibitors from fifteen different countries showed examples of their products, which in addition to machine tools included welding equipment, precision small tools, gauges and measuring apparatus, plastic moulding equipment and a great variety of accessories. The exhibits covered a floor area of nearly 350,000 square feet and for a number of the heavier machines special foundations were laid down. The existing power facilities were also supplemented by the installation of nine temporary substations to provide adequate supplies to run the machines for demonstration purposes.

The fact that within the last three years there have been two other European Machine Tool Exhibitions and the International Machine Tool Exhibition at Olympia made it unlikely that there would be any outstanding new developments amongst the 2500 machines exhibited this year. There has been, of course, a steady broadening of the sizes and capacities of machines of more recent design and an introduction of modifications and improvements as a result of increasing use in industry. What was particularly noticeable, however, was the steadily increasing use of automatic control means incorporated in the machines themselves, and the very wide use being made of automatic sizing equipment and copying apparatus. With these equipments built into machines the rates of production to increasingly closer limits of accuracy continue to grow, with less call for skill on the part of the operators.

W. E. Sykes, Ltd.

The horizontal and vertical gear generating machines, universal hobbers, and other equipment exhibited by W. E. Sykes, Ltd., Staines, Middlesex, included the "Model 3C" horizontal multi-cutter gear generator illustrated in Fig. 1. This machine produces gears up to 40in diameter by 10in face width and it generates external and internal spur and helical gears, splines and serrations. On it both helices of a double helical gear can be cut at once, whether the teeth are staggered, overlapping, or continuous, and the tooth apices are cleaned out accurately by the rotary generating action of the cutters.

Sixteen or more blanks can be cut simultaneously with four cutters on the machine. The speed ratio between the two cutter spindles can be varied to enable two elements of a cluster gear having different diameters and numbers of teeth, with the same or different helices, to be cut simultaneously. The machine is automatic in operation and can be set to finish the work in one, two, three or four cuts. At the commencement of each cut the saddle automatically advances by an amount that can be preset by simple adjustment to three rollers. On completion of the final cut the machine stops and the saddle retracts.

The two vertical gear generators shown by this firm can, when fitted with rack forming attachments, have their capacity increased to produce intricate irregular forms such as pawls and triggers.

A universal hobber exhibited was the smallest of three models with capacities up to 40in diameter, and had a capacity of 14in diameter by 9in face width. Spur and helical gears up to 60 deg. worms, worm-wheels and splines can be generated on these machines. A built-in differential unit facilitates the production of helical gears and enables any number of teeth to be cut, including prime numbers, with a minimum of six teeth.

H. Ernault-Batignolles

The eight representative designs of copy turning lathes shown by H. Ernault-Batignolles, of Paris, included two of the firm's "Pilote" automatic multi-cycling hydraulic machines with 30in centres and arranged to swing up to 13¾in over the bed. One of these two machines—that illustrated in Fig. 2—is also fitted with an automatic hydraulic overhead slide for independent cutting during the machining cycle.

According to the class of work for which it is required, this machine can be fitted with driving motors ranging from 12 h.p. to 40 h.p. Drive from the motor is transmitted through multi-vee belts and multi-disc clutches and an electro-mechanical brake is fitted. Through pick-off gears ten spindle speeds from 380 to 3000 r.p.m. are available. The spindle is bored 2in diameter and has a short overhung chuck mounting. The feed mechanism input shaft is driven from a vee pulley at the rear of the spindle.

The lead screw is driven through gears, and in addition to feed rate changes by pick-off gears it is possible through the drive to effect automatic reduction of 2·5 to 1 at any feed and speed. The feed range is from 0·0035in to 0·0354in per revolution of the spindle. The lead screw is not directly used for screw-cutting purposes but serves only to control the "piloted" hydraulic feed, and the arrangement of this hydraulic mechanism can be seen in the diagram, Fig. 3.

A hydraulic cylinder *A* has a piston *B* and the lead screw *C* is driven through gearing from the spindle of the machine. This screw is in constant mesh with a non-reversing pinion *D* attached to the saddle of the lathe.

There is a certain amount of axial clearance in the fit of screw *C* in its bearings, and one end of it is kept by spring pressure in constant contact with the top of valve *E*, which controls the admission of oil under pressure to cylinder *A*. Thus piston *B* and the carriage duplicate the constant speed travel imparted by screw *C* to pinion *D*. Hand control is by rotating pinion *D* by means of a handwheel *F*, through an electro-magnetic clutch *G*. Operation of the "piloting" device can be compared with a copying device in which pinion *D* would be the tracer and the screw thread the template. As the variations in the shape of the template, in copying, would give impulses to the tracer to be reproduced by the tool, so the longitudinal carriage stroke is a scale reproduction of the screw thread length.

Tools are clamped on the saddle of the machine in the vertical position and during copying operations the saddle lead screw is driven through a cone clutch. This clutch

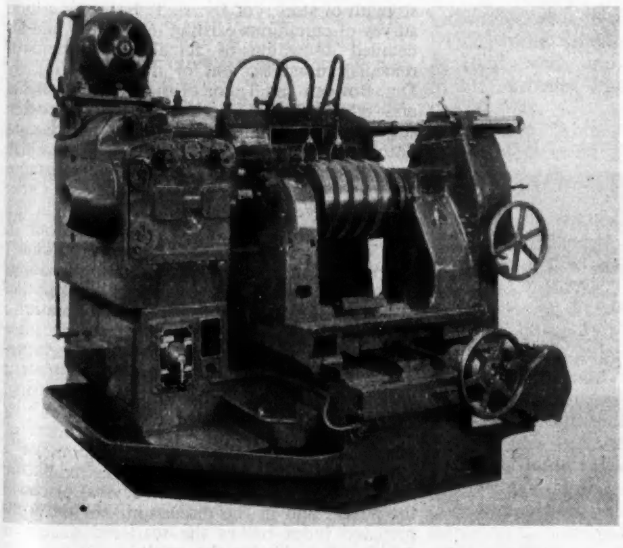

Fig. 1—Horizontal Multi-Cutter Gear Generator—Sykes

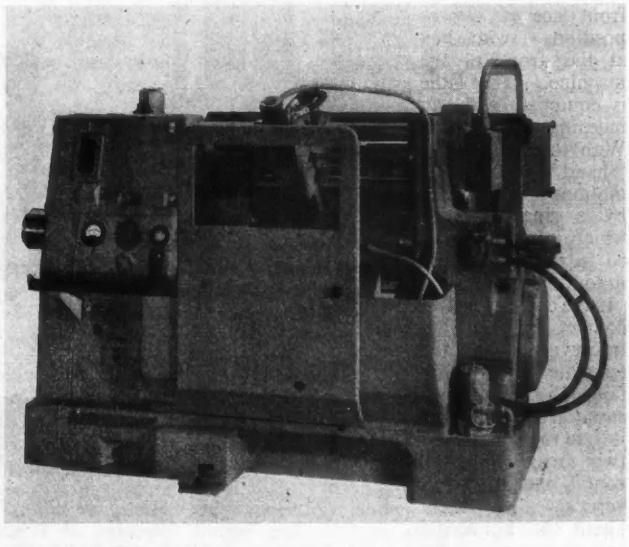

Fig. 2—Copying Lathe—H.E-B.

is normally held in engagement by a strong spring, but can be disconnected electrically by a solenoid and a second spring. The solenoid is normally energised, but when the copying tracer contacts a shoulder on the template the circuit is broken, thus releasing the second spring and causing the clutch to slip while the tracer feeds out to clear the shoulder. At the same time a second cone clutch is engaged which ensures a very rapid arrest. This arrangement is stated to be extremely sensitive and able to maintain distances between shoulders to within 0·0015in.

Master templates are set in a fixture mounted between finely adjustable centres, set on the table above the machine at the rear. The carrier can be made to rotate during the cycle and is driven by a small motor. Set at the rear is an eight position stop-bar which rotates with the template carrier so that it presents the correct stop for the ensuing machining pass. The feed solenoid circuit is also broken when the carriage contacts one of seven adjustable stops on the bar. These stops operate equally well whether the feed is towards or away from the headstock.

Automatic cycling is controlled by contactors through relays and the master control is by a push button mounted on the front face of a two-position switch-box at the front of the machine. The lathe is equipped with an indexing control box. With the box in the "hand" position all motions are controlled by a single joystick which is safely proofed in that it can only follow the cycle.

In the copying system contact between the tracer point and the template is maintained by spring pressure. The tracer arm is free to swing about two axes, one horizontal and the other vertical. Movement about the horizontal axis alters the valve opening in the hydraulic system and causes the tool slide to move across the saddle. Movement of the tracer arm about the vertical axis is detected by the micro-switch which controls the feed shaft motion.

The machine tool division of H. Ernault-Batignolles is represented in this country by H.E.B. Machine Tools, Ltd., 5–17, Haverstock Hill, London, N.W.3.

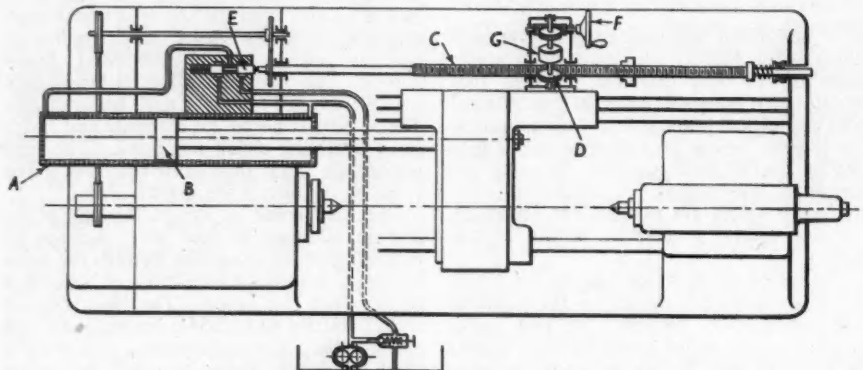

Fig. 3—"Piloted" Hydraulic Feed Traverse—H.E-B.

Wm. Asquith, Ltd.

Amongst the British built machine tools exhibited was a representative group of radial drilling machines made by William Asquith, Ltd., of Halifax. One of these machines is illustrated in Fig. 4. It is a 10ft machine with a drilling capacity of up to 3½in diameter in mild steel and 4in diameter in cast iron, and is one of a range made in nominal sizes from 6ft to 12ft radius.

This machine has a heavy box form base and at the top of its pillar is a box mounted on ball bearings which houses the collector gear and the electrical connection to the spindle slide. The elevating screw which terminates at the pillar top box does not rotate, and the design of the arm casting is such that only a small portion of the screw is exposed when the arm is in the topmost position. The arm ways on which the slide travels present well proportioned, unbroken flat surfaces to the contacting portions of the slide. A rack and pinion is used to actuate the slide which moves on rollers bearing on the top face of the arm. An elevating box within the arm embodies a rotor and stator unit for driving a worm and worm-wheel which is internally threaded to receive the elevating screw.

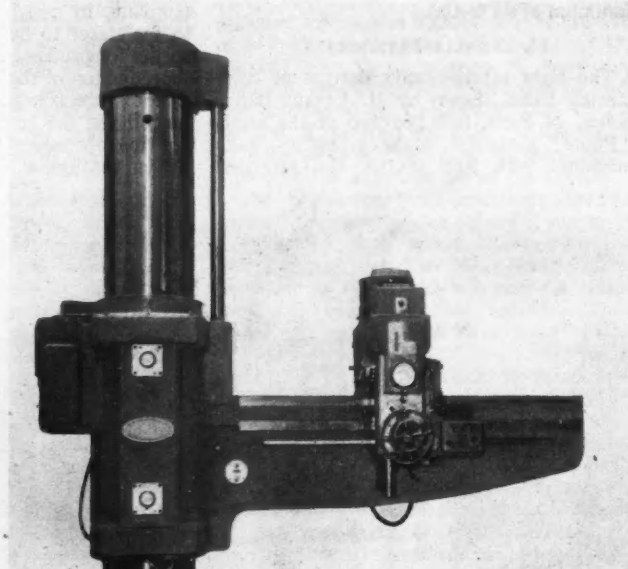

Fig. 4—10ft. Radial Drill—Asquith

The spindle of the machine is carried in the head in pre-loaded ball and roller bearings and is driven by a 15 h.p. reversing motor, flange-mounted on top of the slide. Starting, stopping and reversing of the spindle are controlled by a single lever which also controls the arm elevating motion. Eighteen spindle speeds are available in either of three alternative ranges from 1550 to 19 r.p.m.; 1100 to 14 r.p.m., or 775 to 9½ r.p.m. With the self-applying feed arrangement the spindle is wound down until contact is made with the work, when a slight continuation of downward movement automatically puts the power feed into operation. Reverse movement of the hand-wheel first disengages the feed and then withdraws the spindle. The nine feed speeds available are from 0·002in to 0·040in per spindle revolution and the spindle feed traverse is 1ft 3in.

The machine can be used for tapping holes up to 2½in diameter Whitworth and change wheels can be provided to give the required lead for any recognised thread between 6 and 40 threads per inch.

(To be continued)

Short Notice

Properties of Metallic Surfaces. Institute of Metals Monograph and Report Series, No. 13. London: The Institute of Metals, 4, Grosvenor Gardens, S.W.1. Price 35s.—The thirteen papers contributed to a Symposium on "Properties of Metallic Surfaces," organised by the Institute of Metals and held in London on November 19, 1952, are here presented, together with a full report of the discussion to which they gave rise. Many aspects of the subject—physical, chemical and mechanical—are dealt with, and everyone concerned with the properties of metal surfaces will find information of value in this publication. Many of the subjects of discussion were of interest to engineers. Special mention may be made of Mr. R. J. Love's valuable summary of the influence of surface conditions on the fatigue strength of steel; of Dr. F. T. Barwell's critical survey of conditions existing in bearings and his detailed discussion of actual failures and of remedial measures, and of the description by Drs. Bowden and Tabor of their own researches and other relevant work on friction between rubbing surfaces, the influence of surface condition and the nature of protective films which may be used to ensure low frictional resistance at temperatures up to over 300 deg. Cent. Other matters that receive attention include the influence of surface condition on chemical behaviour in relation to corrosion and corrosion fatigue; the production by diffusion processes of coatings to enhance resistance to corrosion, to oxidation at high temperatures or to mechanical abrasion; the character of the machined surface after drilling, turning, grinding, honing and superfinishing; lubrication of bearing metal surfaces; frictional damage such as scuffing, pitting, abrasion and fretting corrosion, and methods by which such effects may be avoided. Some of these subjects, and also many questions of a more fundamental character, such as the nature of the Beilby layer, crop up in several places in the papers and in the discussion, but the well-prepared index makes the scattered references readily accessible to the reader.

The British Association

No. II—(*Continued from page 335, September 11th*)

The Use of Electronic Methods in Telephone Switching

A PAPER entitled "The Use of Electronic Methods in Telephone Switching" was given by Mr. L. J. Murray, Automatic Telephone and Electric Company, Ltd., Liverpool, to a meeting of Section G (B), on Friday, September 4th. To illustrate the use of electronic methods in controlling the switching of calls one system using such methods was described. But it was not claimed that it necessarily indicated the direction of final progress. The paper concluded that "although it is probable that electronic methods will play an important part in future telephone switching the actual extent and manner of their use is still a matter of some uncertainty."

The Application of Colour to Television Broadcasting

Next, a paper entitled "The Application of Colour to Television Broadcasting" was given by Mr. F. C. McLean, Deputy Chief Engineer, British Broadcasting Corporation. Mr. McLean illustrated his lecture with slides and exhibits.

Mr. McLean, when asked whether the need to produce a compatible system was likely to result in a worse system than if a straightforward colour system was concentrated upon, said that the answer was probably "Yes," but any system would be less good than the best which could be produced. If it was decided to produce the finest television picture there was, money would be spent on apparatus and wavelength space would be used, and the result would be something very difficult to manage. That was probably too high a price to pay. As with the black and white picture, there would have to be a compromise and he did not believe that that would result in anything appreciably worse. As to quality, the flicker problem was less with a compatible system.

The electronic focusing of a beam through two screens had been suggested, but it was difficult to get a screen transparent and to achieve the electronic focusing of a beam after it had been through two screens, and the plan had been dropped, or nearly so. The use of two colours only had been considered, but the general opinion was that it was not good enough and that there must be full three-colour television. He imagined that it would be more difficult to obtain a screen in three colours than to use phosphor dots.

The American method of the transmission of a negative signal instead of a positive signal had some advantages from the point of view of interference but there were disadvantages in synchronising. Both countries had decided on their monochrome basis, and they had now to make their colour systems accord with their decision. There were advantages and disadvantages both ways.

Colour television receivers would undoubtedly be much more difficult to service than the black-and-white receivers, and the training of radio service men to handle them would be a serious problem. It might be no worse than the problem which existed with the advent of television when radio service men who had been handling only sound receivers got down to it somehow and now adequately serviced monochrome receivers. He was not sure but his impression was that the change in technique between sound and television was greater than that between monochrome and colour.

Training for Management

Sir Charles Renold, Renold and Coventry Chain Company, Didsbury, addressed the Education Section (Section L) of the British Association meeting in Liverpool on Friday, September 4th, on "Training For Management."

Sir Charles dealt with the introduction of the university undergraduate into industry and his initial training there as a candidate for eventual managerial responsibility, He emphasised that it was only one aspect of the problem and that graduate training schemes must be matched by keeping under continuous review the progress of staff at all levels and all stages to spot talent and latent capacity and to arrange transfers and promotion to develop it.

The introduction and training of graduates could not be left to chance; there should be a well thought out scheme. The real problem which had to be overcome in devising such a scheme was the lopsidedness of the graduate's equipment for life and the consequent sense of frustration which might arise while he found himself separated from a real job by his lack of practical experience. The initiatory scheme should thus have three objectives. It should seek to reorientate the graduate from the ways of the academic into the life of industry, it should give him a general understanding of the company's business—technological, commercial and organisational—and when he had completed it, it should fit him to take on a real job of some kind with his foot on a managerial ladder.

It was suggested that such a scheme was best run jointly by companies in co-operation with universities, each party making the contribution for which it was particularly fitted. The whole course would last three years, the graduate trainees spending the time partly with the company and partly as full-time sponsored students at the university. The company would give the trainee the feel of industrial life and its disciplines, basic knowledge about its products, processes, markets and organisation, and experience in a range of jobs. The university would provide a background understanding of industry which would illumine and give point to the practical work and would give instruction in the specialist knowledge of the trainee's chosen field.

Professor R. S. Edwards, Professor of Economics, London School of Economics, said that the training suggested by Sir Charles would be in two stages: first, courses in background subjects such as economics, history, law, &c., including, for arts graduates, some introduction to technology and the role of science in industry and, second, courses more directly focused on management. University courses to which the training scheme could be linked already existed. Post-graduate courses in business and industrial administration had long been provided at the London School of Economics and the Manchester College of Technology. There had also been post-war developments at Birmingham and Glasgow.

It was argued that, from the university standpoint, post-graduate work in business administration could hold its own with any other subject as a good academic discipline. It must be conducted largely on the basis of material taken from the actual problems and practices of business but there should be no fetishes in teaching method. There were occasions when case material needed adaptation to drive home some point and there were topics on which straight lecturing secured economy in time without loss of understanding. Businessmen and civil servants were extremely co-operative in the supply of material for post-graduate work. The main difficulty in bringing about a large expansion in management courses lay not in any shortage of case material but in the need for analytical work of high quality and in the problem of securing staff of university level. What was involved was indicated by the L.S.E. course in which seven professors, three readers and four lecturers collaborated.

The facilities available to-day were sufficient to permit a major experiment in co-operation with industry. If thirty or forty firms would each second one trainee in each of the next three years to a post-graduate course in business administration it would be possible to judge whether an academic contribution to business training was worth while or not.

Fifty Years of Powered Flight

On the evening of Friday, September 4th, an evening discourse on the subject of "Fifty Years of Powered Flight" was given by Sir Ben Lockspeiser, K.C.B., F.R.S., Secretary of the Department of Scientific and Industrial Research at the Philharmonic Hall.

Sir Ben, whose address was illustrated by films and slides, dealt non-technically with the history of flying. He said that the Wright brothers succeeded where many had failed because of the relentless scientific attack which they made on the problem of flight, and that the world was not aware of all the gruelling tedious scientific laboratory work which they had to do before flight was possible. The Wright brothers flew for the first time exactly fifty years ago, thus fulfilling a dream which man had cherished throughout the ages. Theirs was a stupendous achievement based on a rare combination of science, invention and engineering. The machines of the Wright brothers, Bleriot, who crossed the Channel, and Alcock and Brown, who flew the Atlantic, changed the course of history.

After the principles of flight had been determined, one of the main objects had been to reduce drag, and now virtually nothing remained of drag from unnecessary sources. The cleaning-up process had been carried to its full limit in the design of the "Comet." The "Comet's" was an absolutely clean design. The engines were buried in the wings and there was nothing in the airstream which need not be there. The "Comet" was not only a piece of fine engineering, but also a very elegant structure.

Sir Ben described the build-up of shock waves around the speed of sound and the effect upon the design of aircraft. He paid tribute to metallurgists and pilots in making possible the great advances which had taken place. Drawing attention to the consequences of high flying speeds, Sir Ben said that one of the prices to be paid was the high rate of fuel consumption. At the beginning of a 2000-mile flight the "Comet" was virtually a flying tanker; on a maximum range journey it weighed 47 tons, of which nearly half represented fuel. Other prices being paid for speed were higher landing and take-off speeds. Fast long-range aircraft were not only inevitably heavy, but also demanded longer and stronger runways, which were very expensive. If aircraft were to become

larger—as they would—and heavier—as they would—the provision of concrete runways would present serious economic difficulties.

The flying boat offered a possible line of escape, for the advances made in recent years had made it a serious competitor. The flying boat always had the advantage of being able to dispense with an undercarriage, which, in a modern large aircraft, might account for 6 per cent of the total structure weight, but for a long time that was more than offset by the excessive size and weight of the hull which had to carry the engines high above the water to keep them clear of the spray. Jet propulsion had changed all that, and a smaller hull combined with improvements in aerodynamic design might well tip the balance in favour of flying boats for all-up weights of 50 tons and more. We were a maritime Commonwealth, and suitable waterways for the operation of flying boats could be found in almost all Commonwealth countries. Flying boats required prepared waterways, and aircraft the size of the "Princess" and the "Duchess" required docking facilities. Many people believed that the cost of providing prepared waterways and docking facilities of that kind would be far less than the cost of very large land aerodromes. He did not know that that would be so, but it was likely. It had to be remembered that the strength of a runway could not be increased by putting concrete on top of it. Therefore, heavier aircraft would require the building of new runways, and that was very expensive and the runways took up a lot of good agricultural land. He believed that before this century was out flying ships carrying a thousand passengers or more would be operating on the transatlantic and transcontinental routes. He believed that this would be dictated by technological as well as economic considerations. The serious problem of noise would be dealt with by transferring the operation of modern aircraft from densely populated areas to the sea.

Time and Motion Study

Two papers on time and motion study, one by Miss A. G. Shaw, Anne Shaw, Ltd., Heald Green, Cheadle, Cheshire, entitled "The Use of Motion Study in Increasing Productivity," and one by Mr. Winston Rodgers, Department of Scientific and Industrial Research, entitled "Techniques in Motion and Time Study," were presented at a joint session of Section G (A) (Engineering) and Section J (Psychology) on Monday, September 7th.

Miss Shaw said that motion study implied the study of the needs of the operator at work, and while it made use of a number of definite techniques for recording and examining methods, that was only one side of the subject. No method of work was of the slightest use until it was in operation in the factory. In most motion study work often more time was spent on the human problems of changing methods than was spent on devising the improvements. That was the side of motion study that she wished to emphasise ; the most modern aspects of the application of motion study techniques on the shop floor rather than the latest development in techniques devised in the laboratory.

Each motion study investigation was unique, being concerned with one set of people in one particular set of circumstances, and thus each study must begin by an examination of the whole field of the investigation. It was important, for instance, to know from the beginning whether short-term or long-term results were the aim. A 25 per cent improvement in the following week was sometimes more valuable than a 50 per cent improvement in six months' time when the market might have been lost. On the other hand, where there was unlikely to be any change in product for a long period and there was no danger of losing customers, it might be worth while making the maximum improvement, although it might take longer to plan and install. Another consideration in deciding the object, and therefore the nature, of an investigation might be the question of the priority of machine efficiency over operator efficiency or vice versa.

Coming closer to the detail of the problem, it was necessary to know whether the quantity of work fluctuated seasonally or for any other reason, whether it would be possible to allow the production of a larger quantity of work by the same number of operators, or whether the saving would have to take the form of a reduced labour force producing the same quantity as before. In the last case, immediate arrangements would be needed for placing surplus operators on other suitable work before they were redundant.

The co-operation of both worker and supervisor was essential throughout any motion study investigation. Most opposition came from a lack of understanding and a fear of the unknown, and if the objectives and methods of motion study were fully understood and the benefits of improvements made self-evident, co-operation would be much more likely. Managers, supervisors and operators should be trained to understand simple motion study and to join in its application so that every improvement was the result of team work and, as such, much more widely acceptable.

Mr. Rodgers noted a growing realisation of the considerable influence of motion and time study in increasing production, during the past few years corresponding interest had been aroused in the practices of motion and time study. An examination of the practices showed that the qualitative or fact-finding procedures were simple enough exercises in their purely mechanical content, but the benefit to be derived from their use was directly proportional to the ability of the user. That was at once a weakness and a danger. It was a weakness because no confidence could be placed on the reliability of the findings and a danger because managements, in a desire to push the application of motion and time study, might well overlook the fact that what was done could not be divorced from the person doing it.

However, assuming that the fact-finding techniques provided information which was considered adequate for practical purposes, considerable reliance must be placed on individual judgment and experience in interpreting the facts and engineering a working method. There were as yet no well defined steps in the building-up process and few norms for comparative purposes. Thus, when it was stated that a 50 or 100 per cent increase in output had been achieved by application of motion study techniques, the improvement might merely lift the original output from the "very poor" to the "poor." However, the increase might be sufficiently impressive to lull management into a sense of satisfaction. To that lack of objectivity must be added, at least at the industrial or working level, an inadequate association between the findings of the experimental industrial psychologist, the physiologist and the motion study practitioner. An association whose activities might well bridge the gap was the Ergonomics Society. When attention was directed to stop-watch time study practices the weaknesses were even more serious. For instance, there were the vexed questions of the reliability to be attached to the subjective assessment of an operator's working performance, the nature and value of fatigue and other allowances.

Mr. Rodgers said that those criticisms were not intended to deny the very real contribution which motion and time study had made to increasing productivity but rather to emphasise the need for research and closer co-operation between research workers where their fields of activity merged.

(To be continued)

Cornish Engines Preservation Society

Last Saturday, September 12th, members of the Cornish Engines Preservation Society and many distinguished visitors gathered at Camborne to take part in two interesting ceremonies. Many of them spent part of the morning preceding the ceremonies visiting the nearby 90in Cornish beam pumping engine working at "East Pool" Mine, and the 80in example working at South Crofty. The first-named of these engines is already the property of the Society. It was built by Harvey and Co., of Hayle, in 1892, for Carn Brea mines and transferred to its present site in 1924. The Society hopes to be able to acquire the other, which is likely to be replaced by electric pumps next year. It was built in 1854, to the design of a celebrated Cornish engineer, Samuel Grose, by Sandys, Vivian and Co., of Copperhaus, Hayle. After working at Wheal Alfred, Crenver and Wheal Abraham, and Tregurtha Downs mines, it was re-erected on its present site in 1903, where it has been operating almost continuously night and day ever since.

After a lunch held in the canteen of Holman Brothers, Ltd., the company proceeded to the nearby village of Penponds. There a plaque on a cottage in which Richard Trevithick lived for many years was unveiled by his great-grandson, Captain R. E. Trevithick. In introducing Captain Trevithick to those present Lord Falmouth, President of the Society, also welcomed the presence of Mr. Olivey, through whose generosity the cottage, which has now been fully restored, was originally acquired. The plaque when unveiled was seen to read :

RICHARD TREVITHICK
1771–1833
THE ENGINEER
AND
PIONEER OF HIGH PRESSURE STEAM
LIVED HERE

The party then returned to Camborne and assembled in the Research and Museum block of Holman Brothers, Ltd., opposite Trevithick's statue. There, by the removal of a staircase and certain minor structural alterations, room has been found for the re-erection of a 22in rotative engine from Rostowrack Clayworks, presented to the Society by Lord Falmouth. This engine was built by West and Son, of St. Blazey, to the design of William West, and first erected at Locking Gate, Bugle, in 1851. Ten years later it was removed to Rostowrack, where it remained in operation until 1952. Lord Falmouth formally handed over the engine to the Society, saying that the engine had had a long and useful life. They could call it a leisurely life, with its 20 revolutions per minute as against the 3000 revolutions per minute of modern turbine machinery. He remarked that but for the placing of the present site at the disposal of the Society by Mr. Treve Holman, the engine must have gone for scrap. The engine was then started up, working under compressed air. Lord Falmouth also unveiled a tablet in the "engine house," which reads :

ROSTOWRACK
CORNISH ROTATIVE BEAM ENGINE
PRESENTED TO THE CORNISH
ENGINES PRESERVATION SOCIETY
BY THE RIGHT HONOURABLE
THE VISCOUNT FALMOUTH
12TH SEPTEMBER, 1953

Tea was then taken in the adjoining Holman Brothers' museum and the film on Cornish Engines made by the Shell film unit was shown. Many new members were enrolled.

Speed Control of A.C. Winders

The control system described in this article is designed to give a direct relationship between the steady rope speed of an a.c. electric winder and the position of the driver's power lever. Protection is also provided against the incidence of excessive torque, irrespective of the human element in the operation of the power lever.

WE have received some details of a system of speed control for a.c. electric winders, which has been developed by the General Electric Company, Ltd. With this system driving, dynamic braking and reverse current braking are effected by a power lever operating in a single gate or slot and, under suitable conditions, regenerative braking is available at maximum winder speed. From the driver's point of view the operation of an a.c. winder with this system of control is closely similar to established practice for d.c. equipments.

Briefly, the system is such that when the winder motor is running at the preselected speed, the control gear is in a state of equilibrium, but any change disturbs this state and the speed is automatically adjusted until balance is re-established. A quick movement of the lever from " stop " to any position will cause the maximum safe torque to be developed by the motor until the selected speed is reached, after which this speed will be maintained irrespective of load, dynamic braking being applied automatically if the load calls for it. Similarly, a quick movement of the lever from " full speed " to an intermediate position will apply dynamic braking until the selected speed is reached, after which this speed will be maintained automatically by driving or braking as needed. Movement of the lever from " forward " through " stop " to " reverse," or vice versa, will apply reverse-current braking.

The control scheme can be considered, for convenience, under four main headings. The first is the rotor control system which automatically adjusts the resistance in the rotor circuit to the correct value for any conditions of speed and loads. The second is the speed signalling system which compares the speed selected by the driver with the actual speed at any moment and passes a suitable impulse or signal to the rotor control circuit. The third is the excitation system and the fourth is the working of the scheme as a whole.

The Rotor Control System

It can be shown that, when dynamic braking is applied to an induction motor, the maximum braking torque at any given excitation and speed is developed when :

Rotor circuit resistance = speed $\times k_1$, where k_1 is a constant.

A similar relationship for maximum torque when driving or plug braking can be shown to be necessary at any given speed, namely :

Rotor circuit resistance = slip $\times k_2$, where k_2 is a constant.

It will be evident that by adjusting k_1 and k_2 the maximum, or any chosen torque, may be maintained at optimum conditions.

In the scheme considered here, the resistance in the rotor circuit is varied automatically so as to comply with the above conditions. This effect is obtained through the action of a hydraulic servo-mechanism by means of which the resistance in the rotor circuit is adjusted automatically to the optimum value at all times. The rotor resistor may take the form either of metallic grids or a liquid controller.

The basic elements of the circuit are as shown in Fig. 1. The rotor resistor R is varied by a hydraulic servo-mechanism, under the control of two opposing coils LR (" lower resistance ") and RR (" raise resistance "). The coil LR is energised by alternating current, the value of which is determined by the torque and speed signalling as described below. When driving, this current varies with the speed error in a ratio of about 2 : 1 ; when dynamic braking, this current is constant. The coil RR, which opposes LR, is supplied from the stator or secondary winding of a control generator CG driven by the winder motor WM. Thus, at any given rotor or primary excitation of CG, the voltage across RR reflects that of the rotor of the main winder motor, and varies directly with the slip or speed.

The primary excitation of CG is derived from the controllable reactor CR_2. For simplicity, this reactor, like others used in the scheme, is referred to as a magnetic amplifier because controllable reactors serve as the actual amplifying elements in any magnetic amplifier circuit. The magnetic amplifier CR_2 is controlled by the speed-error signal in such a way that for zero or small errors the excitation of RR is high and decreases with increasing error in speed, i.e. the greater the speed error the smaller the excitation of RR. This reduction, however, is subject to a limiting value.

The total variation of torque in driving is controlled by a simultaneous variation of the LR current and the control generator voltage across RR, both of which are functions of the signal current, but act in opposition to each other. The control generator voltage can vary in a ratio of about 1 : 6 at any speed, which, together with the variation of 1 : 2 of the current in the LR coil, gives a total torque control ratio of 1 : 12. On the other hand, when dynamic braking is used, the same total torque control ratio is achieved with a constant current in the LR coil, because the variation of torque with d.c. excitation is of the order of 2 : 1, so that the excitation control ratio of 1 : 6 is sufficient to give the required 1 : 12 total torque control ratio. The variation of the LR coil excitation is kept to a minimum in order to preserve a high degree of sensitivity of the servo-regulator.

A variable resistor R_1 is also connected in the RR circuit and is actuated by the servo-mechanism and arranged so that its value always reflects that of the rotor resistor R. As the frequency of the voltage V is that produced by the slip, it is very low at high speeds, and, to avoid pulsation of the hydraulic servo-gear, the whole RR circuit is made two-phase. Since the temperature coefficient of the metallic resistor R_1 is small, while that of the liquid resistor R is large, some compensation must be made for the very considerable variation in R with temperature. This compensation is effected by means of a small fixed liquid resistor RS, connected in parallel with the coil LR ; the resistor, being fitted in a pocket in the liquid controller, is therefore subject to the same temperature variation as R.

If the driver's lever is moved from " stop " (by more than 25 per cent of its travel) a fixed maximum a.c. excitation appears in the coil LR, while the control generator CG receives minimum excitation. Simultaneously, the coil RR is excited by the equivalent of the rotor standstill volts. At this instant the coil RR is in series with the whole of R_1, so that a small current passes, an equivalent small current passing through R in the rotor circuit of the winder motor. Under these conditions the coil LR prevails and cuts out R_1 and R together. If, for the sake of argument, the mechanical brake has not been released, a point is reached where the reduction in R_1 is such that the increase in the current in RR is sufficient to produce a pull which balances that of LR. The operating valve then closes and the motion of the servo-mechanism is arrested. The circuit resistances are so chosen that at this instant the motor is exerting its maximum torque. If the brake be now released, the winder motor will accelerate, and both its slipring volts and equivalent voltage V from the control generator will fall. The current in RR is accordingly reduced, and LR again takes control and opens the operating valve. Thus the servo resumes its motion and R and R_1 are further reduced so that the pulls exerted by RR and LR are kept very nearly in a state of balance.

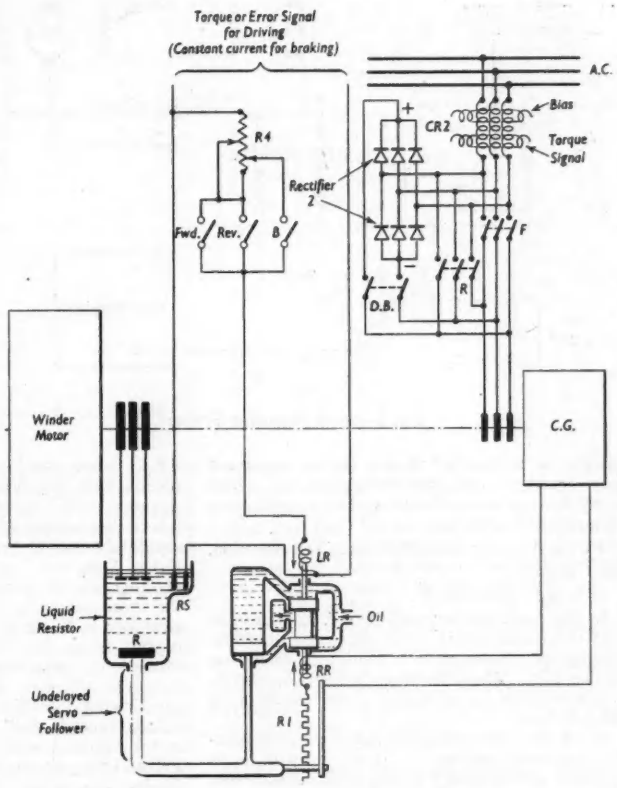

Fig 1—Rotor Control System

From the foregoing it will be noted that during acceleration :

Ampere-turns in LR = ampere-turns in RR + the constant weight effect.

Now ampere-turns in LR are constant during this period. The ampere-turns in RR will be nearly constant so that the current in RR will be nearly constant, i.e.:

$$V/r_1 = k,$$

but

V = per cent slip $\times$ rotor standstill volts V_1 (V_1 being a constant),

so

R_1 = per cent slip $\times V_1/k$,

i.e.

R_1 = slip $\times k_2$,

Now the winder rotor resistor R is proportional to R_1, just as the winder rotor voltage is proportional to V_1, and thus the fundamental requirement for constant torque performance, namely, $R = k_2 \times$ slip, is fulfilled.

This relationship holds good for any value of slip and therefore covers reverse-current braking, when the slip exceeds 100 per cent. It will

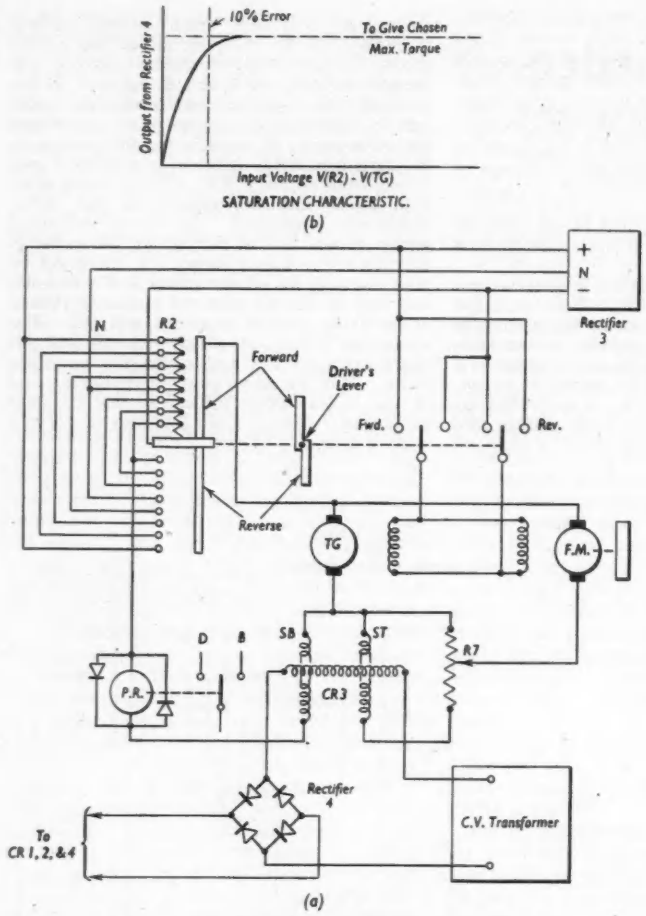

Fig. 2—Speed Signalling System

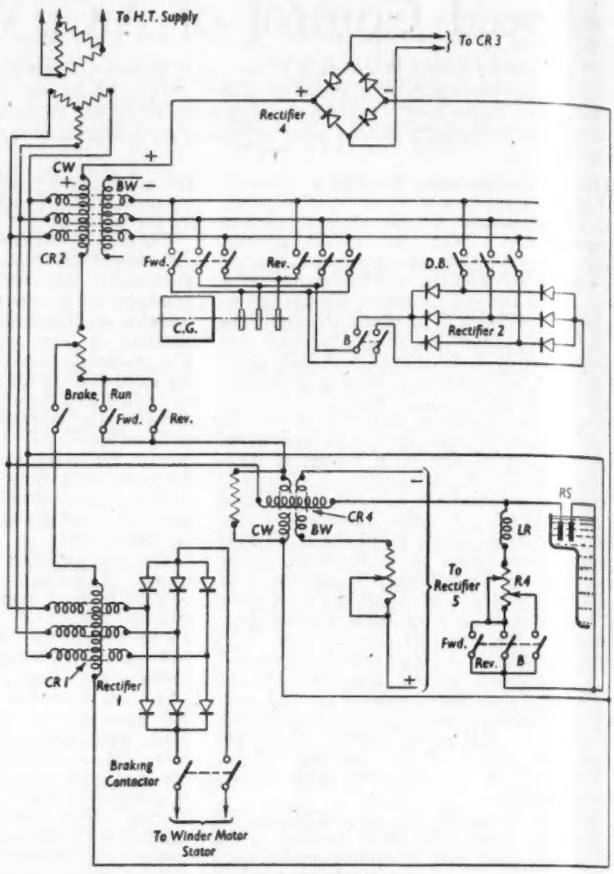

Fig. 3—Excitation System

readily be understood that a similar argument may be developed for the conditions which apply during dynamic braking, the only difference being that in this case :

V=speed × rotor volts at full speed and excitation, and hence,

R=speed × a constant k_1.

In this case k_1 varies with the d.c. excitation so that the fundamental requirement for optimum braking performance with minimum excitation is also met. The difference between k_2 and k_1 is effected (Fig. 1) by adjusting the resistor R_4 in the *LR* circuit.

It will thus be appreciated that during acceleration or deceleration the rotor resistor R is adjusted automatically to ensure maximum safe torque output from the motor. As the required speed is approached, the speed-error signal diminishes, which in turn increases the excitation of the control generator, and hence its voltage V. At the same time, the current in the *LR* coil is reduced. These changes alter the values of the constants k_1 or k_2 to give the correct electrical conditions for the winder motor at the torque demanded by the load. Variations in the load during the wind will cause only a slight speed variation which is, however, enough to adjust the value of k_1 or k_2 to correspond.

The Speed-Signalling System

This circuit is shown in simplified form at (*a*), Fig. 2. At "stop" the driver's lever is in the middle of a "gate" and its first lateral movement selects the direction or rotation of the motor. Further movement in either slot actuates a d.c. potentiometer R_2, by means of which a "pattern" or reference voltage is selected, which determines the final steady speed of the winder. This voltage is balanced against a voltage from the tachometer-generator *TG* through the speed-balancing winding *SB* of the magnetic amplifier CR_3. This winding is in series with the polarised relay *PR* which determines whether the motor drives or brakes. Across the terminals of the tacho-generator *TG* is a small motor *FM* fitted with a flywheel, and connected in series with the stabilising winding *ST* of the magnetic amplifier CR_3. Since the "pattern" voltage does not reverse with the movement of the driver's lever through "off," provision is made whereby the lateral movement of this lever reverses the separately excited fields of *TG* and *FM*. Thus, if the "pattern" voltage exceeds that of the tacho-generator, a current will circulate through the speed-balancing winding *SB* of the magnetic amplifier CR_3 and produce a corresponding output from the rectifier 4 which feeds the excitation circuits described below. At the same time, the polarised relay *PR* sets up the circuits for driving. Similarly, if the tacho-generator voltage exceeds the "pattern" voltage, a current in the opposite sense will pass through *SB* and *PR*, and the polarised relay will set up the circuits for braking. The potentiometer R_2 is tapped in such a way that a residual pattern voltage is still present in the "stop" position to give a brake signal down to zero tacho-generator voltage. This ensures that maximum dynamic braking is available down to the lowest possible speed.

As the winder motor accelerates or decelerates in response to a change in the "pattern" voltage, the current through the flywheel motor *FM* varies in proportion to the rate of change. This current, circulating in the stabilising winding *ST* of the magnetic amplifier CR_3, opposes the effect of the speed-balancing winding *SB* and so provides the "negative feed-back" necessary for stability. A resistor R_7, connected across the winding *ST*, enables this feed-back to be adjusted to suit any particular installation.

The characteristics of the magnetic amplifier CR_3, combined with those of the rectifier 4, are such that, for a small difference between the "pattern" and *TG* voltages, the output from the rectifier 4 is proportional to this difference, but for larger differences no further increase in output takes place, (*b*) Fig. 2. The design of the magnetic amplifiers, &c., energised from rectifier 4, is such that the maximum output of this rectifier corresponds to a preselected maximum torque output from the winder motor.

To protect the polarised relay *PR* from excessive current without forfeiting sensitivity, its main coil is shunted by two rectifiers which serve to by-pass current as soon as the normal operating voltage of the relay is substantially exceeded. Two additional bias windings on this relay enable the operating voltage to be adjusted, and to differ for "driving" and "braking" and to compensate for the idling current of the motor *FM*. These windings may be adjusted to prevent unnecessary changes from driving to braking, and thereby obviate unnecessary wear on the main contactors.

The Excitation System

The system of excitation is shown diagrammatically in Fig. 3. The output from the rectifier 4 feeds the control windings of the magnetic amplifier CR_2, which are in series with those of the amplifiers CR_1 (braking) and CR_4 (driving). The amplifier CR_2 is associated with the a.c. excitation of the control generator *CG* when driving, or with its d.c. excitation through the rectifier 2 when braking. The magnetic amplifier CR_1 is associated with the rectifier 1 which supplies the braking d.c. excitation to the winder motor *WM*.

The amplifier CR_4 controls the a/c. supply for the compensating resistor *RS* from which the excitation for the *LR* coil is derived in accordance with the requirements dictated by the signal current.

The Complete Control System

The operation of the scheme (Fig. 4) can be understood more easily by considering the sequences following various quick motions of the driver's lever.

(*a*) "*Stop*" *to* "*Half Speed Forward*."—Movement of the driver's lever through the gate immediately sets up control circuits for the "forward" direction. Further movement to the half-speed forward position causes the regulator R_2 to apply 50 per cent of its maximum voltage to the speed-error signalling loop "*TG–CR*$_3$*(SB)–PR*" circuit. The current in the winding *SB* saturates the amplifier CR_3 which produces its maximum output. At the same time, the relay *PR* closes contacts which set up the main contactor circuits for "driving."

The rectifier 4, associated with CR_3, also

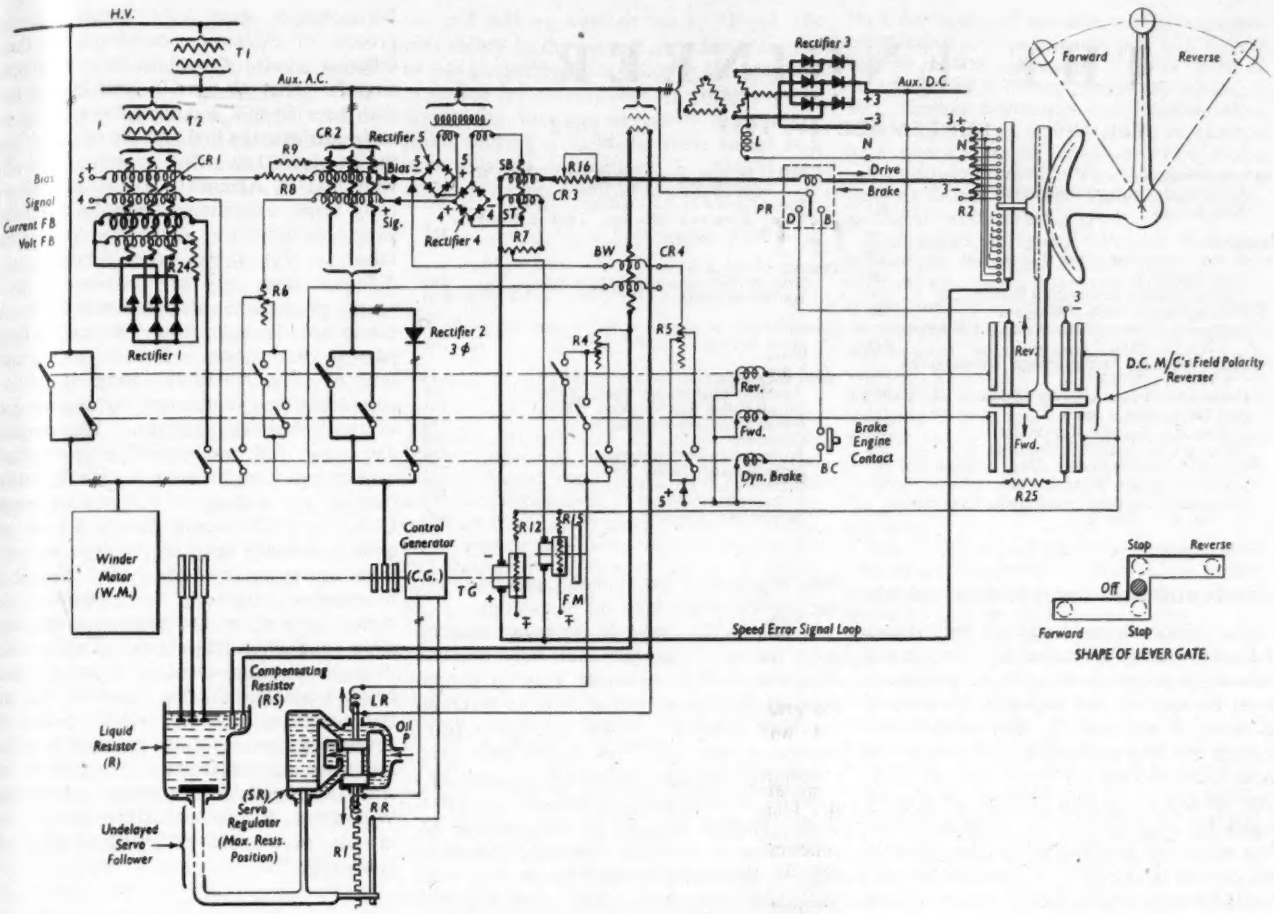

Fig. 4—Speed Control System for A.C. Winders

delivers its maximum output to the control windings of the amplifiers CR_3 and CR_4. As the control winding opposes the bias winding of CR_2 this amplifier gives minimum output and, hence, minimum excitation of the control generator *CG*, which is connected directly to CR_3 by the " forward " contactor.

On the other hand, as the control winding assists the bias winding *BW* of the amplifier CR_4, the output from this amplifier produces maximum excitation of the coil *LR* of the hydraulic servo-mechanism. Thus the pull of the coil *LR* is able to overcome that of the coil *RR* and the winder motor *WM* accelerates at the chosen maximum torque as described under the heading " Rotor Control System." As the motor gathers speed the tacho-generator voltage rises, and in consequence the current in the speed-balancing winding *SB* falls ; no change takes place, however, in the output from CR_3 and rectifier 4, because this amplifier remains saturated. Acceleration continues, therefore, at maximum torque until the actual speed approaches that selected, after which the output voltage of the amplifier CR_4 is rapidly reduced, causing the current in the coil *LR* to fall and the excitation of *CG* to increase, until the torque of the winder motor equals the load torque, so that the speed no longer increases.

As the amplifier CR_4 is excited by the amplifier CR_3 via the rectifier 4, the reduction in its output actually occurs a little earlier, because the current taken by *FM* in accelerating with the rising voltage of the tacho-generator *TG*, traverses the stabilising winding *ST* of the amplifier CR_3. As this current diminishes with the acceleration of *FM*, a stabilising effect is introduced which prevents any tendency for the speed to overshoot the selected value.

As winding proceeds, the down-going load increases with the length of rope until, in the case of a deep wind, it will ultimately exceed the up-going load. In this event the speed will rise until it exceeds that set by the driver's lever, when the tacho-generator voltage will exceed the pattern voltage, and the current in *SB* and *PR* will be reversed. The reversal of current in *SB* has no effect, because the amplifier CR_3 is non-directional and gives the same output for a given control current in either direction. The relay *PR*, however, is polarised and changes over its contacts, thus causing the main driving contactor to open and the main braking contactor to close.

As a result, the output from the amplifier CR_3 and the rectifier 4 is transferred to the amplifiers CR_1 and CR_2, while CR_4 receives constant excitation. The amplifier CR_1 now supplies an increasing d.c. excitation to the stator of the winder motor *WM* until the braking effort is sufficient to balance the down-going load. A slightly higher speed will be needed to maintain this condition. During this set of circumstances the amplifier CR_2 supplies d.c. excitation to the control generator *CG* which, in turn, supplies the coil *RR*.

On entering the retarding zone, the driver's lever is moved back to reduce speed. The tacho-generator voltage then substantially exceeds the " pattern " voltage and full braking excitation (limited by the amplifier characteristics) is applied, so that maximum braking torque is developed. On reaching bank, the act of setting the mechanical brakes opens the dynamic braking contactor via the contact *BC*.

(*b*) " *Stop* " *to* " *Full Speed Forward* " : *Regenerative Braking*.—Acceleration to full speed will take place at maximum torque, as under the condition (*a*) above. Assuming that the wind is such that regenerative braking is possible, this will begin on a slight rise in speed above synchronism, the resistor R_5 being set to permit the necessary increase without changing over to dynamic braking. On entering the retarding zone a backward movement of the driver's lever will cause the polarised relay, *PR*, to change over and initiate dynamic braking.

(*c*) " *Full Speed Forward* " *to* " *Full Speed Reverse* ": *Reverse-Current Braking or Plugging*. —The first movement of the driver's lever from " forward " towards " stop " will initiate dynamic braking, since the " pattern " speed will be less than the actual speed. When the lever passes through " stop " towards " reverse," the " pattern " voltage increases once more in the same direction, but as the fields of *TG* and *FM* are reversed the " pattern " and tacho-generator voltages are now additive. The polarised relay *PR*, therefore, maintains the " driving " circuits and reverse-current braking is applied at maximum torque and under optimum conditions as described above.

An interlock circuit, omitted from the diagram for simplicity, ensures that the resistors *R* and R_1 are at their maximum values before the " reverse " main contactor can close.

Report on the Bradford Railway Accident

THE report has now been published of the inquiry into the accident which occurred on May 20th last at Forster Square Station, Bradford, as the result of which one passenger was killed and fourteen were injured. In this accident a shunting engine drawing six empty coaches from platform four passed the platform starting signal at danger and collided sidelong with the 7.15 a.m. Skipton to Bradford passenger train which was entering platform five under clear signals. The shunting engine struck the leading coach, tearing out its side as well as that of the second coach, all the compartment partitions and seats of the two coaches and those of the leading end of the third coach being destroyed. Colonel McMullen, the inspecting officer, concluded that the accident was caused by the failure of the shunting engine driver to observe a signal at danger. The signal was well sited and not only did the driver fail to see it, but also to look in the direction in which shunting movement was proceeding. The report remarks that the accident would have been prevented by facing trap points near the platform starting signal. The regularity of the particular shunting movement and the fact that drivers habitually draw up to the signal which was close to the fouling point are arguments for such points.

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AFTERTHOUGHTS UPON FARNBOROUGH

Once again a flying display has been staged at Farnborough. Now that it is over, many millions of people must again be pondering about the exciting and unpredictable pace of aeronautical evolution in this present era. Perhaps the least spectacular craft seen at the show were the gas-turbined civil airliners. They are not as yet shot into the air at crazy angles by augmented thrust devices! One does not cringe involuntarily at their passing nor gasp at their antics! There are no tail-braking parachutes to signify any particular hazard or difficulty on their landing. Nevertheless these aircraft represent a peculiarly British triumph to which no other nation has contributed. With them, in one bold venture, this country has completely overcome the ascendancy of American manufacturers in world air transport. After the war American makers, having amassed vast manufacturing and operational experience with piston-engined craft, complacently laid out production lines to satisfy the large post-war world demand for new airliners. They felt assured that the demand would be for American aircraft; most nations had, in fact, no experience of any other machines. The aircraft were very good aircraft—there were none better. But they were powered by piston engines. The task, daring if not desperate, which faced this country if it was to compete in the civil aeronautical field, was completely to by-pass the ascendancy which the Americans established in the piston engine world and to build a series of faster, more complex machines around that then little-known quantity, the gas turbine. That unit, although basically simple, brought with its adoption many problems for solution, particularly as it was only available at first, as for the "Comet" project, in its least economical form. For such a challenge to have hope of success it was necessary for at least one company to commit itself to the production of such craft "from the drawing board" even though much about their characteristics had then still to be resolved. As we now know, the venture, both with turbo-propeller and turbo-jet aircraft, has proved an unqualified triumph for British engineering skill. In its turbo-jet form the venture has probably proved to be the greatest single leap yet in aviation.

It was to the credit of American makers after the war that they not only quickly designed aircraft, but that they produced them at so high a rate as soon to saturate the high demand. It was through a production policy that they established their superiority and then retained it by applying, quickly, accumulated experience to later craft. In that way design was wedded to production, a necessary marriage for leadership in the transport world. In that way leadership was won. Only through the British development of gas turbine propulsion for civil airliners has it been lost. But there have been such upheavals before. There was reluctance here to see the biplane go; there was no haste here to abandon the tail-wheel landing arrangement. But American makers swept them away. Now, in their turn, they have been forced to admit that British makers have swept the piston engine away! It will, however, not be long before the reaction is pointedly manifest. There are signs that American designers are attempting to by-pass the present development stages of civil jet aircraft and are applying their already considerable jet bomber experience to much larger craft. It is well to remember that one company alone is already producing the "B 47," a six-jet very high speed bomber at the rate of over two a day which is as complex and heavier than most aircraft in this country; and the same company is reported to be mass producing two jet bomber aircraft in the "Brabazon" weight category. The need for British makers to extend and consolidate their present lead is urgent. The lead will be strengthened by every operational jet flying hour by which they can anticipate the American challenge. Distinctively in our favour are the facts that we still clearly make better engines than the Americans and that the economics of turbo-jet aircraft are so critical that they can be heavily affected by small differences in fuel consumption and specific weight. Nevertheless many of those who saw the new civil airliners on display at Farnborough must be pondering whether Britain's lead in design is being adequately matched by production policy.

In the military sphere the observer at Farnborough must have noted that the process of evaluation continues on three different kinds of medium-weight bomber aircraft. They all have in common the fact that the wing root is designed to envelop the undercarriage, the fuel and the engine, if not the jet pipe. This policy contrasts markedly with that in America. There, at a fairly early stage, a decision to adopt a particular wing configuration seems to have been taken. But it is quite fundamentally different from any of our own! Here again production factors involved in its fabrication have probably played a large part in the choice. The internal structure of the American wing is almost completely uncompromised by engine, fuel or undercarriage stowage. The engines and some fuel are carried in pods from cantilevered wing struts or, as with the undercarriage, are located with fuel in the fuselage. Consequently American designers have had quite a different crop of problems to solve than those under study here. But it is nevertheless surprising that American designers have committed themselves to large-scale production of a kind of wing which diverges so fundamentally from all three being evaluated in this country. It will be interesting to see which policy in developing wing forms eventually proves the more advantageous. Productively the American policy has some advantages. Will there be compensation for Britain in the more rapid gathering of technical knowledge?

THE RIVAL BOMBS

The news that Russia claims to have been successful in her thermo-nuclear experiment and so has added a hydrogen bomb to her potential arsenal has certainly caused some political stir. It was natural that it should do so since it is but a few years since many scientists felt by no means sure that such a weapon could be made at all. We had been told by astronomers that the fusion of certain of the lighter elements of the periodic table in the interior of the sun was the means of maintaining its temperature, and therefore the flow of radiant energy so necessary to life on our planet; we were also told that for this process to occur the temperature inside that great crucible needed to be many millions of degrees. It followed that if the building of a hydrogen bomb were ever to be undertaken, a temperature of this sort might have somehow to be provided, and how was any such temperature to be obtained so that the desired reaction could begin? In any work of this kind there is naturally a heavy surrounding cloud of secrecy. None the less, it was pretty well known that when the older kind of atom bomb—that using an isotope of uranium—was detonated there was attained at the very core of the explosion a temperature of a million or more degrees. So it became a fairly sure guess that if a hydrogen bomb could be made at all it would need to have a uranium bomb to act as detonator, and thus become a more complex piece of apparatus than ever. But just as the explosive power of the first uranium bomb ever made proved to be about a thousand times as powerful as its T.N.T. predecessor, so the hydrogen variety might, in theory at

any rate, show an equal jump in explosive power.

Just as it is America that has succeeded in creating the largest stock-pile in the world of fissile material for atomic bombs, so also it was the earliest to claim success in making the first experimental hydrogen bomb. We have since learned from Russian statements, which are confirmed by distant American radio-active observations, that the U.S.S.R. has now succeeded in making its own first hydrogen bomb. How far the Anglo-Australian experimental establishments may have got in this same direction is not disclosed, nor is there evidence to cause us to believe that any other country has got anywhere at all. But even if, as now appears, the hydrogen bomb can be made, is it of any use when it is made? Would not the uranium bomb, which is easier to make, provide perhaps as much energy as can be efficiently used? These are important questions and they need to be answered. So far in this discussion it has been assumed that some form of military use is the prime objective. If this were not the case, and if it were desired to use this new source of energy for civil purposes, there could be little doubt as to what our choice would be. For from the raw material used to make the uranium bomb, one may produce either an explosion or a slow and steady release of energy, whilst from the thermo-nuclear reaction it seems that the product can only be explosive, and so of no use at all for the supply of the energy which some day might be needed to replace our dwindling, or growingly inaccessible, supplies of coal. On this score, therefore, uranium, with its twin possibilities of both civil and military use, would be easily the winner. It is arguable also that even when looked at solely from the military angle the uranium bomb is the more efficient weapon of the two because of the increasing accuracy with which, over any given range, the weapon can be employed. For accuracy makes it unnecessary to use an intensity of explosive that might "over-kill" the target. That possibility is one which only military experts can adequately discuss and decide upon, and their view, no doubt, must depend in some measure on the nature of the target. If the latter be, let us say, an ammunition store, an oil tank installation, a railway junction or a storage reservoir forming part of a water power scheme, there is presumably a certain optimum explosive power for the bomb to have; though, in the present state of knowledge, this may not be so sure if the target be a submerged submarine. However, with so very little information made public, this is an issue that must needs be left to the informed expert.

The ever-useful radar, as well as other forms of radio, as a means of guidance to a target has grown greatly in accuracy in recent years, is likely to grow yet further, and can be applied just as well to the new guided missiles as to manned aircraft. The greater this accuracy in delivery, the less, obviously, the explosive power needed to carry out any designed task; the less accurate it is the more intensely explosive must be the bomb. No one, however, would choose to employ the less efficient of two tools, and it may happen that the more we learn about the hydrogen bomb the less in the end will we want to use it. From this may follow in due course a readiness to ban its use altogether while keeping the uranium explosive for employment in artillery or in bombs (as long as we needs must arm), whilst looking to it in the years ahead as a very welcome replacement, in part at any rate, for our present fossil forms of fuel.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

ROLE OF EXPERIMENTS IN APPLIED SCIENCE

SIR,—In a review of my book, *Studies in Elastic Structures*, which appeared in your issue of August 14th, the reviewer questioned the role of experiments in applied science. He expressed doubt as to the propriety of raising such a general question in a review, but argued that the matter was fundamental to the philosophy of engineering science and called for discussion.

I should normally hesitate to enter into correspondence on a review of my own book, but because I agree so strongly with your reviewer as to the importance of this issue, I would like to develop my views somewhat in the hope of provoking the discussion he desires.

I have in an earlier book, *The Experimental Study of Structures*, suggested that experiments fall broadly into five groups, viz.:

(*a*) Exploratory experiments made before mathematical analysis.

(*b*) Confirmatory experiments made after analysis.

(*c*) Experiments made in conjunction with analysis to provide essential data or to obtain empirical formulas.

(*d*) Analytical experiments to replace computation in specific problems.

(*e*) Experiments of an *ad hoc* nature.

The last of these can be excluded from the present discussion since they would be classified by your reviewer as "tests" and all engineers will agree as to their necessity.

In group (*a*) I include such experiments as those on the arch made of steel voussoirs, which are described in the book under review. These led to an understanding of the mechanics of voussoir arches and indicated a basis upon which such structures could be analysed. Later, experiments were made on larger arches with voussoirs made of two different concretes and jointed in two very different types of mortar. These, falling into group (*b*), were designed to show to what extent the methods based on the behaviour of the idealised structure could be applied to arches built more in accordance with actual practice. They provided information which could not, I believe, have been obtained by any other method and were thereby justified.

In the early years of engineering science it was common for large numbers of tests to be made on particular structural units and the results used to deduce empirical formulas for design purposes; the result of this method may be seen, for example, in the numerous formulas propounded for determining the strength of struts. It is not very satisfactory, and although it may prove convenient on occasion to summarise experience in this way, a far better approach is to study a problem as completely as possible by mathematical analysis and to fill the almost inevitable gaps by means of data obtained experimentally in a systematic manner. The numerous strut formulas just mentioned have, for example, been replaced in this country by the Perry-Robertson formula obtained exactly in this way. The original analytical treatment due to Professor John Perry contained a constant, depending upon the cross section of the strut and its equivalent initial curvature, the evaluation of which could only be made experimentally. As the result of an analysis by Professor Andrew Robertson of large numbers of tests from many sources, values were assigned to the constant which transformed an academic statement of strut behaviour into a valuable design formula which soon became the basis of British practice. This type of experimentation falls into group (*c*).

Experiments in group (*d*) are becoming increasingly important. Many engineers, for example, now realise that elaborate computation in the analysis of certain types of stiff-jointed frameworks can be short-circuited by simple displacement measurements made on small celluloid models, and whether such experiments are used as a substitute for the initial design calculations or simply as a completely independent check upon them, they are of great value not only for the actual results obtained, but because they lead to clearer understanding of the behaviour of the structures which they represent.

The doubt, expressed by your reviewer, as to whether it is worth while to reproduce in experiments the simplifying assumptions of the theory seems to indicate a misunderstanding of my position. It is true that in a very few instances experiments are mentioned which do no more than what he suggests, i.e. support computation because the assumptions of the analysis are accurately reproduced. As examples of this may be quoted a simple experiment on the deflections of a tightly stretched wire and an experimental check on the influence line of a bow girder. These experiments, however, were very simply and quickly made with existing apparatus, and while I agree that to the mathematician they are entirely superfluous, I have to confess that as an engineer I still derive pleasure in seeing such easily contrived experiments produce calculated results. More than this, on those occasions when the results differ I am grateful for the indication that something may have gone wrong. Very few experiments of this kind are mentioned, however, and perhaps reference to more elaborate experimental researches will serve best to explain my attitude. In connection with the airship programme in the years following the 1914–1918 war, new methods of analysis for braced tubular pin-jointed frameworks were based on certain assumptions as to the stiffness of bulkheads. The Airship Stressing Panel of the Air Ministry suggested the advisability of verifying these and experiments were accordingly made on braced hexagon tubular frames. The first frame was made to correspond as nearly as possible with the assumptions of the theory and the close agreement between the results obtained by calculation and experiment gave confidence in the experimental technique employed. If the work had stopped at this point I should be compelled to agree with the views of your reviewer that it was hardly worth while, but in fact this was only a beginning.

The structure was successively modified in different ways to cover cases outside the theoretical treatment, e.g. by the omission of bracing in certain bulkheads, by variation in the stiffness of such bracing, by fixing a nose piece on the tube to modify the resistance of the end bulkhead against distortion out of its plane, and so on. It was also used to determine the applicability of Saint-Venant's principle to a braced tube—a matter not only of considerable importance for the airship stressing scheme, but also one of scientific interest. Finally, a completely new model was made to determine the effect of continuous longitudinal members.

The second series of experiments to which I would refer were those on wire wheels, which well illustrate group (*b*). An early analysis had shown the impracticability of obtaining an accurate numerical result for the stresses in a wire wheel with more than six spokes owing to

the labour involved in solving ill-conditioned equations, and a new approach was made based on the assumption that a finite number of spokes could be replaced by an idealised disc of peculiar properties. The treatment of this idealised structure was straightforward, and from the results the loads in individual spokes were deduced by integrating radial forces in the disc over the appropriate arc of the rim. This was, I believe, the first use of this device and no evidence was available as to its limitations. In consequence a number of simplified wheels were built and the forces in the spokes due to rim loads were measured. Experiments on wheels with three, four and six spokes respectively showed that the analysis was accurate and that the experimental technique was satisfactory, so that it was possible to proceed with confidence to the experimental analysis of wheels with twelve and twenty-four spokes. Calculations for these were intractable by the first analysis, but quite simple using the second, or idealised disc, treatment. A comparison of calculated and experimental values of the spoke loads enabled deductions to be made as to the scope and limitations of the new method of analysis.

Other experiments were made at later dates with the object of testing the value of this method of attack—the *leitmotiv* of the book, to quote your reviewer—when applied to a variety of problems, and I believe that those experiments were well worth while.

These illustrations and explanations may serve to show that with very few exceptions the experiments cited in the book are not of the simple type that one might show a student to illustrate, say, the triangle of forces, but were designed to explore points not readily amenable to theoretical analysis.

In conclusion, I suggest that, apart altogether from the purposes which I have outlined, there is a sound psychological objective in an experiment which demonstrates the validity of an engineering calculation even though the assumptions and treatment upon which it is based are in themselves entirely convincing to the mathematical mind. Many engineers are unwilling to apply a new method based on mathematical analysis alone, but if the results obtained can be reproduced experimentally they are much happier in its acceptance and use. Since the primary function of the engineering scientist is to help those engaged in the practice of the profession, any legitimate means of emphasising the value or, better still, the necessity of scientific approach, should be exploited. In my view, most types of experiment provide valuable means of increasing co-operation between the scientist and the practitioner by inspiring confidence. It will be unfortunate if the laboratory does not maintain its position in engineering research and development.

A. J. SUTTON PIPPARD

Imperial College, London, S.W.7,
September 7th.

THE HARROW ACCIDENT

SIR,—As the son of a former driver I was specially interested in the letter from Mr. Lawrence in your issue dated September 4th.

Strong support to what Mr. Lawrence says regarding the possibility of an accident on the footplate is given by the signalman's statement, immediately after the disaster, that when the locomotive passed his box he could not see either the driver or the fireman.

Though footplate accidents are rare, they can be very serious and it may well be that the engine crew only managed what they did towards stopping by a superhuman effort.

C. W. WHITMORE

Hatch End, Middlesex,
September 8th.

Fifty Years of Undercarriage Development

No. V—(*Concluded from page 332, Sept. 11th*)

In concluding this article on the evolution of the undercarriage we give some further details of bogie installations and some smaller undercarriages are mentioned. A number of German and American developments are described and the future of wheeled installation development is discussed.

THE most recent bogie installation to fly in this country is that fitted to the latest version of the "Valiant" bomber, which is made by Vickers-Armstrongs, Ltd., another of the aircraft firms which still design and manufacture their own undercarriages. As this aircraft made its maiden flight only early this month, no details are available, but it can be seen from our illustration that each leg mounts twin tandem wheels and retracts backwards into a wing blister which extends aft of the trailing edge.

In the original Mk. I "Valiant" aircraft, however, an attempt was made to use an unarticulated installation, each leg consisting of two telescopic members braced in tandem, which could retract outwards to lay flat in the wing.

It can be observed from the illustration Fig. 33 that two telescopic legs form the

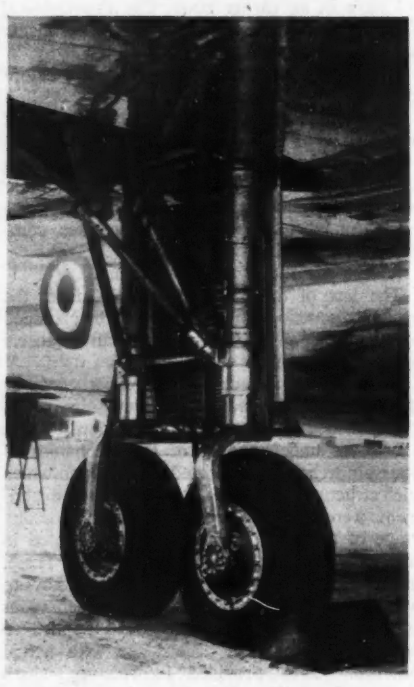


Fig. 33—Main Leg of the Vickers "Valiant B I"

verticals of a space frame with the diagonal member having a special section.

Both main frames mount two wheels in tandem, each wheel being carried by a half fork integral with the ram. It is apparent on observation of the size and shape of the cylinder which forms the diagonal bracing member, and of the pipes which connect at its upper end from the top of each leg, that this member probably serves as the oleo-pneumatic unit for both legs, oil being ejected by both rams to this unit, which contains the air chamber and presumably incorporates a floating piston and cylinder head restrictor orifices. The diagonal chamber, when loaded in this manner, thus serves as the anti-pitching damper also, and it can be noted that no other damping unit is fitted. The system is, perhaps, analogous to the "Comet" installation, with a hydraulic linkage replacing the vertical and horizontal levers and the subsidiary damper of that installation.

There are no anti-swivel links on the wheel half levers in this installation, their function being undertaken by the horizontal tubular member which joins them at the bottom. This unit, which can be clearly seen on the installation, appears to be of telescopic design, which apparently can expand to permit independent displacement of either leg, but which restricts swivelling by its resistance in pure bending.

An example of a tricycle bogie undercarriage designed for operation from unprepared runways and soft ground is that fitted to the "Beverley" freighter aircraft, which is made by the Blackburn and General Aircraft, Ltd., and illustrated in Figs 34 and 35.

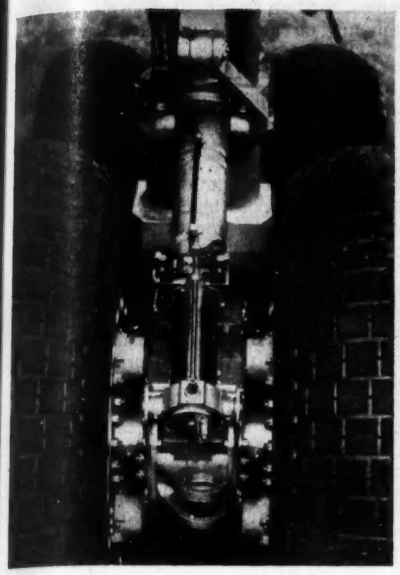
The two main non-retractable undercarriage units each carry a four-wheel tandem bogie. The semi-cantilever shock absorbers are designed and manufactured by Automotive Products Company, Ltd., and carry the beam of the bogie in a forked bottom fitting. The outer cylinder of each shock absorber is attached to the main plane at its upper end and is supported from the bottom corners of the spar frames in the fuselage by a faired sponson member. The sponson has two built-up spars which converge at the shock absorber and is covered with light alloy sheet. The eight main wheel tyres are Dunlop $43 \times 13 \cdot 50$—19 operating at 63 lb per square inch at 130,000 lb all-up weight. Pitching oscillations of the bogie beam are controlled by an oleo-spring damper.

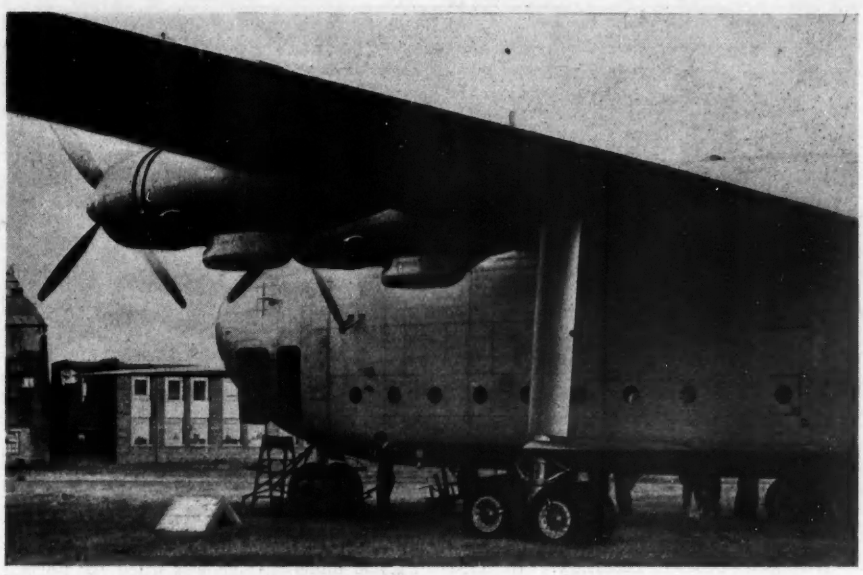
On the production aircraft it is proposed to fit the automatic "Maxaret" brake units. As this installation is not retractable, a feature of the design is the low frontal area attained. No brake torque compensation linkage has been fitted, the maximum braking torque being adjusted to suit the dynamic load distribution thus occurring on the axles.

It will be evident from these different constructions that as yet there are several points of view on certain characteristics of bogie installations. One condition on which designers differ is the problem arising from the slamming tendency of the front wheels. This possibility has been eliminated by Dowty, but is stated to be viewed less seriously by British Messier, Ltd., It will also be noted that Electro Hydraulics, Ltd., employs two oleos, (one being on the bogie) each of considerable capacity. This the company maintains, when deployed as explained, has a weight advantage over a single oleo, a view which is not shared either by Dowty or British Messier.

SOME POST-WAR TRENDS IN AMERICA

Immediately after the war the Americans developed a number of multi-engined jet aircraft which had not the swept configuration and on which the engines were mounted in pairs within a common nacelle on each wing. Amongst these were the North





Figs. 34 and 35—The Blackburn Universal Freighter

American B45 "Tornado" of 82,000 lb all-up weight, and the first multi-engined bomber to fly in America (early in 1947), the Curtiss night fighter "XF87" prototype and the Convair "XB46" of 91,000 lb all-up weight. It was still practical with all these aircraft to adopt a conventional undercarriage, the "Tornado" leg retracting inwards into the wing, those of the "XB46" were mounted from the nacelles, into which each leg retracted, and the Curtiss installation was also wing mounted and housed. The prototype Convair "B36" was also of this vintage and at the time of its first flight in 1946 endeavoured to retain a single main wheel on each leg. This aircraft has an all-up weight of 358,000 lb, which exceeds that of the "Brabazon," and, in spite of the size of its wheels (9ft 2in diameter), it was necessary on all the production aircraft to mount a four-wheel bogie,* the wheel track being 48ft. Wing housed single wheel units were used on the Northrop "Scorpion," a high-speed, thin-wing, twin-engined night fighter, but here recourse was necessary to large-diameter thin wheels operating with tyre pressures of 200 lb per square inch.

Later, in 1947, however, came the first of the American prototype six-engined jet bomber aircraft with all-up weights exceeding 100,000 lb. These aircraft provided first evidence of American preference for the sharply-swept wing of low thickness/chord ratio, but showing little taper spanwise, in distinction to the British high-speed wing, also of small thickness/chord ratio, but by virtue of a large root chord providing accommodation for engines, undercarriage and fuel. The Americans have evolved highly advanced techniques for the quantity production of its high-speed wing, and our reproductions illustrate the characteristic arrangements of engine and undercarriage which its geometry dictates. The engines are either slung forward and below the wing in cantilevered nacelles or they are suspended from the fuselage itself, whilst the undercarriage consists of double-wheeled main legs located in tandem within the fuselage, the front legs being steerable, and wing outriggers providing lateral stability. The Boeing "B47," of which there are several experimental and production marks weighing up to 180,000 lb, falls into this category, its engines being carried from the wings, which are set with anhedral. It has single legs in tandem and, as can be seen in our illustration of the scaled-up version of this aircraft, Fig. 36, the "B52," there are four legs in two tandem pairs. This machine, which has eight turbo-jet engines, each of 10,000 lb static thrust, weighs over 300,000 lb and has a wing span of 185ft, and is now in production.

The first of the six-engine jet aircraft was the Martin "XB48," which had a straight thin wing with integral nacelles, each housing three engines. This does not appear to have been proceeded with and the company is now engaged on the manufacture of a smaller light bomber of about 100,000 lb all-up weight, the "B51," which first flew in 1949 (Fig. 37). This has a very thin swept wing of variable incidence and is set with anhedral, two of its three engines being suspended in pods from the fuselage, the other being housed in the tail. Apart from any advantages which might accrue from a variable incidence wing, it is particularly necessary with the fuselage tandem gear to facilitate take-off, which is compromised by the weight distribution with this layout. Amongst some other unconventional installations is that fitted to a single-engined experimental fighter aircraft, first flown by the Republic Aviation Corporation in 1949. It is fitted with a variable incidence swept wing having its greater chord at the wing tip, into which the small tandem wheels of each main leg are retracted. The Douglas "Skystreak" thin straight wing research aircraft was another machine needing to use tyre pressures in the region of 200 lb per square inch in order to accommodate the suspension in the wing. With the swept wing version known as the "Skyrocket" a fuselage mounted

Fig. 36—Boeing "YB 52" with Twin Tandem Gear

* Fig. 24 *ante*.

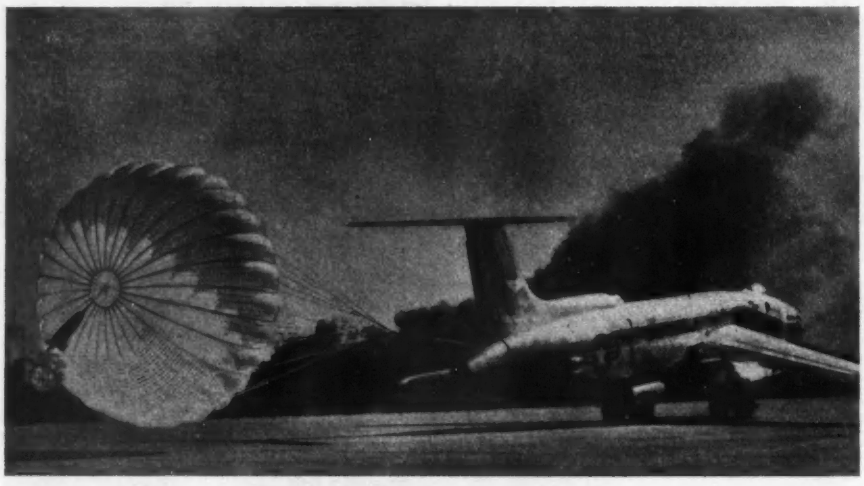


Fig. 37—The Martin " XB 51 " Tandem Gear

tricycle gear became necessary. In 1951 this piloted aircraft first flew at 1238 m.p.h., and this year attained a height of 82,000ft.

The Bell " X2 " and the " X5 " supersonic research machine, the latter having a variable swept wing, are both fitted with fuselage mounted tricycle gear.

An earlier improvised solution in America was the mechanically independent tandem twin-wheeled oleos forming the main leg of the Lockheed " Constitution," a 128-passenger aircraft of 184,000 lb all-up weight. The use of four main legs was tried in this country also by Vickers-Armstrongs, Ltd., on the " Windsor," a four-engined bomber which was developed towards the end of the war. Each leg was located from and retracted into the nacelles.

German Wartime Development.—Apart from the articulated and levered systems, to which we have already referred, German undercarriage design, not without considerable ingenuity, had already begun to reflect the influence of this new family of aerodynamic and structural problems, even before the end of the war.

What may prove yet to be a very significant venture was the installation fitted to the Arado " AR234," a twin jet-engined aircraft, which first flew in 1942. This aircraft was fitted with retractable skids and during take-off it was mounted on a short-tricycle trolley which was jettisoned. It was not proceeded with, however, and the later " 234C " production aircraft with four pod-mounted engines were fitted with fuselage mounted tricycle gear. The Messerschmitt " Komet " swept, tailless, rocket-propelled fighter was similarly converted to a fuselage-mounted tricycle gear. Earlier production versions made by Messerschmitt had a jettisonable twin-wheeled chassis, the aircraft landing on a belly skid and tail wheel.

Mass production had also started on the Heinkel " He 162A," another high-speed aircraft with a tricycle gear mounted from the fuselage. With this jet aircraft the engine was mounted in a pod above the fuselage. More conventional was an earlier Messerschmitt twin jet machine, which first flew in 1940. It had underslung wing-mounted engines, the undercarriage retracting into the wing roots.

Of German piston-engined aircraft the most unusual arrangements were the multi-wheeled installations of the Arado " 232B " and the " Me 323 " military transports, which were required to be able to operate from unprepared surfaces. In the former, an aircraft of about 50,000 lb all-up weight, a tricycle undercarriage was fitted for normal operation, which could be collapsed so that the aircraft rolled on eleven cantilevered twin-wheeled units arranged in tandem on the longitudinal axes of the aircraft. On the much larger " Me 323," which had six engines of 1000 h.p. each, and an all-up weight of 100,000 lb, there were ten main wheels mounted through coil springs to each side of the fuselage in tandem fives. Six of these were main wheels aligned under the wing roots; the front wheels were smaller and reached towards the nose.

The Germans also produced an aircraft using four main legs. This was the Junkers " 390 " transport aircraft of 161,000 lb all-up weight and large even on present standards. It had six engines and the oleos were located and housed in the four inboard engine nacelles.

Independent oleos located side by side in each nacelle formed the main legs of the heavy twin-engined Heinkel " 177 " and they divided spanwise into the inner and outer wing when retracted. Unusual also were the twin-wheeled main legs of the " Me 264," which first flew in 1942, a four-engined long-range bomber, one wheel of each of which was jettisoned during retraction. Although used elsewhere also, the Germans, particularly the Messerschmitt and Junker companies, used on several of their medium-sized twin-engined aircraft, notably the Junkers " 88 " series, the system of rotating the wheel assembly through 90 deg. with respect to the leg, so that with backward retraction into the leg it lay flat in the nacelle.

British Fighter and Light Bomber Aircraft.—In this country smaller undercarriages have so far remained conventional, although on at least one high-speed machine recourse to tyre pressures in the region of 200 lb per square inch is known. Both the " Meteor " and " Canberra " aircraft—these being the first production twin-engined jet aircraft—had wing-mounted engines, and our illustration (Fig. 39) shows the oleo and single-wheel installation of the " Canberra " with inboard retraction. The " Meteor " undercarriage, to which we have made earlier reference, was similarly located and retracted. Even with the later fuselage-mounted twin-engined machines, such as the swept wing " DH 110," the " Javelin " and " 508 " aircraft, a similar location and retraction has been possible ; in the latter case, however, it appears that the wheels retract into the engine blisters.

Wheel Assemblies.—So far, in meeting these new structural and aerodynamic requirements, the bogie undercarriage has contributed to that primary consideration of landing gear design of achieving a lower structural weight ratio, although acquiring some complexity. It is perhaps time now to consider what have been the consequences to the design of wheel, brake and tyre of conceding to these more recent dimensional and loading demands, and of the increased landing speed and heat dissipation factors involved. Although mention of these components has been left to the last, it is this assembly as much as any other component which threatens first to become most critical when that still yet vague conception of the ultimate sized land-based aircraft is examined.

The most insistent demand to which the tyre manufacturer has been subjected has been the need to design tyres which can show a reasonable life when operating with pressures now approaching 300 lb per square inch in special cases. The worst evil attendant on higher tyre pressures is the proneness of the tyre to concussion failure should it encounter small obstructions on the pavement. It is also more prone to

Fig. 38—Boeing " B 47 " Using A.T.O. Units

abrasive wear and yet at the same time it is subject to higher peripheral speeds due, in the first case, to higher landing speeds generally and in many installations also to its smaller diameter. The need to provide a stronger tyre leads to a heavier one. To combat this tendency the Dunlop Rubber Company, Ltd., has already resorted to nylon in many cases which is 60 per cent stronger than the rayon fabric formerly used. Better orientation of the reinforced fibre is another way by which the problem of tyre weight and strength is being tackled.

The question of heat dissipation has become even more difficult. With the kinetic energy increasing as the square of the landing speed, the problem of braking is aggravated both by the tendency of landing speeds and braking torques to increase and wheel mass and braking area to decrease. In the last ten years braking heat generation has increased from 200 B.Th.U. per second to 1000 B.Th.U. per second, and in the latest Dunlop installation the twin slotted discs floating in the wheel rim attain temperatures of the order of 1000 deg. Fah. The minimum weight and size of the wheel are thus quite clearly determined by the need to provide discs of suitable cooling area and sufficient mass so that the tyre can be isolated thermally.

Fig. 39—The "Canberra" Installation

Future Developments

Enough has been said of the undercarriage to stress how exhaustive endeavour has been to constrain the growth of this "parasitic" component; meeting with ever more arduous demands yet conceding ground only in terms of complexity to cheat strength/weight ratio laws which it cannot deny; and finally, with the bogie installation, achieving perhaps its ideal form as a retractable-wheeled structure. But already the meticulous detail design and the use of the latest and lightest alloys in their construction would seem to rule out any further significant gain from these considerations. Moreover, it seems that any further demands on the wheel assembly will incur a weight penalty and likewise, because of its beam form, the bogie itself can accede to greater dimensional requirements only at a disadvantage to its own strength/weight ratio. The bogie unit is consequently likely to depart increasingly from its present 3 per cent ratio as its size increases. It was explained in our issue of April 3rd, page 511, how marginal the pay loads appear expressed as a percentage of the all-up weight of turbo-jet aircraft. The above trend, supposing it applied only to the undercarriage, could therefore make such inroads into the capacity pay load as quickly to dictate an ultimate economic size for civil aircraft. The use of take-off thrust augmentation and aerodynamic drag and negative thrust braking devices in reducing the length and cost of runways would merely postpone this event. The continuous track undercarriage has been investigated both in this country and America. It has, however, many inherent disadvantages and compares unfavourably with the bogie. Skid undercarriages with jettisonable or ground-based take-off chassis offer a weight advantage, but if restrictions upon the flexibility of civil aircraft of this order can be countenanced, the argument for the flying boat is immeasurably strengthened.

For it appears that if in the future still larger aircraft are to be developed, the flying boat may prove more economical in that category. It will be apparent from the account given in this article that development of the undercarriage has been both rapid and exhaustive; it has made extraordinarily great demands on engineering skill and ingenuity, and has reached such an advanced stage of refinement as to threaten finality.

It is said of the flying boat, on the other hand, that in growing larger, recent researches will enable it to become structurally and aerodynamically more efficient. This being so, landing problems fade from their present significance. They land on unprepared surfaces, enjoy an elegant suspension agent, cross wind and braking problems are reduced, and it is less inhibited during take-off. Although it would be largely restricted to ports, it might be said in this connection that both forms of transport will need inter-city helicopter facilities in any event.

The diagrams of Figs. 5 and 8 in No. I were reproduced from *Jane's All the World's Aircraft*, 1919, and the illustrations in that part and Figs. 13 and 14 of No. II were reproduced by permission of The Imperial War Museum.

The S.B.A.C. Flying Display and Static Exhibition

No. III—(*Concluded from page* 341, *September* 11*th*)

THIS year at Farnborough an old rivalry has been vigorously revived, for there would no longer appear to be any facet of the performances of the Hawker "Hunter" (Fig. 19) and Vickers "Swift" (Fig. 18) at low levels to distinguish the one from the other. Indeed, Vickers-Armstrongs, Ltd., has already announced its intention to challenge the unconfirmed air speed record established last week in the Hawker "Hunter."

Fig. 18—The Vickers "Swift IV" Fighter

Production of both these aircraft is now well under way. The "Swift" has a wing configuration bearing much similarity with the Vickers "Valiant" having a sharply swept root with reduced leading edge sweep outboard, and its wing span of 32ft 4in made it the smallest military aircraft at the display. It is powered by a Rolls-Royce "Avon" reheat engine.

The "Hunter F1" also has this engine, but it is a noticeably bigger aircraft than the "Swift" although its span is only 16in greater. Both fighters demonstrated transonic dives and on most days the now familiar "sonic bangs" were heard over the field. Their high-speed runs were generally estimated to exceed 700 m.h.p. The Boulton and Paul "P111A" delta, high-speed research machine was also near this speed category. Its delta wing seemed particularly thin and the machine has no tail plane. A Rolls-Royce "Nene" engine is fitted with a nose air intake.

Another aircraft in the very high-speed group was the de Havilland "DH110," which is now under development as an all-weather fighter for the Royal Navy. It has two Rolls-Royce "Avon" engines.

Civil Aircraft

It seems that the success which has attended the British application of gas turbines to civil aircraft and their introduction on world-wide air routes is largely unqualified. The problem which faces the aeronautical industry, having established their worth, is one of satisfying the demand now that financial loan arrangements for foreign buyers have been set up and before America scrambles into the market.

The most dramatic application of the gas turbine to civil air transport results from the use of turbo-jet units where mean cruising speeds of up to 550 m.p.h. are, or shortly will be, attained, by the present series of "Comet" aircraft. The first production aircraft of the Series 1 and 1A have all-up weights of 105,000 lb and 115,000 lb respectively, and cruised according to height at about 490 m.p.h. These aircraft had the

" Ghost " centrifugal engine with a fuel consumption of about 1·02 lb per pound thrust per hour, which is relatively high in comparison with the fuel consumption of the later axial-flow units which are now available. These series had stage lengths of from 1500 to 1750 miles, the capacity payload of the later " 1A " aircraft being 1200 lb.

The latest development of the " Comet," the Series 2 (Fig. 20), with four Rolls-Royce " Avon " axial engines, each giving 6500 lb of thrust, is now in production for B.O.A.C. and other operators. It will carry an increased payload (13,500 lb) over stages exceeding 2000 miles at a slightly higher speed than the Series 1 or 1A. The first production Series 2 " Comet," which flew in August, is now engaged in a programme of test flying.

The " Comet " represents de Havilland's largest undertaking in the civil field. This stage in the development of the " Comet " is now completed, and " Comets " of Series 1 and 1A have completed over 5,000,000 miles of successful service with B.O.A.C., Union Aeromaritime de Transport, Air France, and the Royal Canadian Air Force.

In May, 1953, at the close of the B.O.A.C.'s first full year of operation with its fleet of " Comet 1's," the Corporation had recorded 104,600,000 revenue passenger miles, and 122,000 revenue miles were being flown by " Comets " each week along the routes from London to the Middle East, South Africa, India, Ceylon, the Far East and Japan.

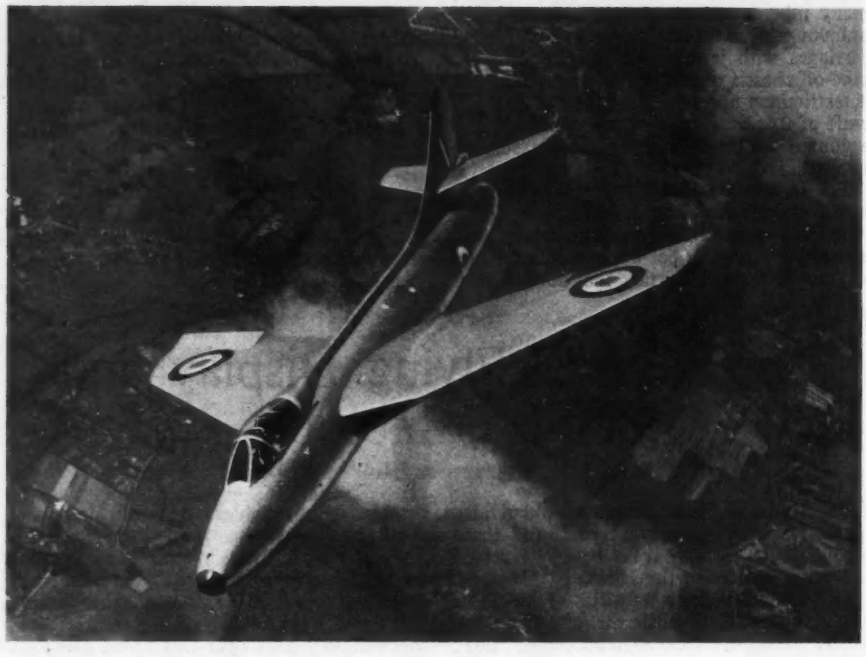


Fig. 19—The Hawker " Hunter "

The " Ghost," the only jet engine in airline service, is accomplishing some 600,000 engine miles per week and has an overhaul life of 600 hours, with an increase to 750 hours imminent. One operator of the " Comet," France's Union Aeromaritime de Transport, has found that its " Ghosts " require half as many man-hours of maintenance as do well-established piston engines of which it has had experience.

The next stage of the " Comet's " development is the Series 3, an advanced airliner for service during the decade beginning in 1956. The prototype is expected to be flying next year. This " Comet," and any subsequent de Havilland airliner, will have to their advantage the valuable experience already gained.

The all-up weight of this series goes up to 145,000 lb, and it can be a seventy-six-passenger machine, powered by the Rolls-Royce " Avon RA 16," the fuel consumption of which has been stated by the maker to be 0·84 lb per pound thrust per hour. The aircraft will have a range of 2500 miles and its capacity payload 20,000 lb.

The Vickers " Viscount " was the first of the turbo-propeller airliners to fly, and a fleet of them are now being operated by British European Airways, which has ordered thirty-eight machines. Production of the present " 700 " series is shown in our illustration (Fig. 21) at the Vickers-Armstrongs works at Weybridge, but shortly all production will be transferred to its new factory at Hurn. Here plans have been made to achieve a production of eight machines a month by 1955. Altogether, eighty-four machines have been ordered.

One of the important aspects of propeller turbine propulsion which has been established is the improved economy which can be achieved per flying hour. Figures published by B.E.A. for the first 2000 flying hours of its " Viscount " operation reveal that after allowing for a full rate of amortisation and 4½ per cent interest on capital, an overall profit of £34 per flying hour was made. The average flight distance on the routes covered for this evaluation was 474 miles and the average load factor was 73 per cent. The lack of vibration with these rotary prime movers is important, not merely because of passenger comfort, but because it reduces maintenance on flying instruments and other equipment.

The standard " Viscount 700 " aircraft has four Rolls-Royce " R.Da.3 Dart " engines. Its all-up weight is 58,500 lb and it has a span of 93ft 8½in and a length of 81ft 2in. It normally cruises at 320 m.p.h. at 20,000ft and it has quite conventional landing, take-off and handling characteristics.

The Bristol " Britannia " turbo-propeller aircraft (Fig. 22) now in super-priority production, is not only the largest of its kind, but will be larger than most civil aircraft now flying. Apart from its advantages, which spring directly from its prime movers, it also enjoys a structural weight advantage, gained from experience with the " Brabazon " project and from a more extensive use of the " Redux " bonding process.

The initial production version is the

Fig. 20—The de Havilland " Comet " Series 2 with " Avon " Engines

Fig. 21—Vickers "Viscount" Propeller Turbine Airliners on Production Line

Mk. 100, with four "Proteus 705" turbo-propeller engines, but three larger and more powerful versions are commercially available. These are the Mk. 200 all-freight aircraft, the Mk. 250 mixed freight and passenger machine, and the Mk. 300 airliner seating 104 passengers in the standard version and up to 120 in high-density versions. All three will have "Proteus 750" turbo-propeller engines of 4150 e.h.p. and a fuselage 10ft 3in longer than the Mk. 100.

Twenty-five Mk. 100 "Britannias" were originally ordered by British Overseas Airways Corporation, but it has since been announced that the Corporation will now have the first fifteen Mk. 100 aircraft and ten Mk. 300.

The "Britannia's" strength lies in its combination of low operating cost, great payload and range, and a cruising speed considerably higher than present standards. The scope of the payload/range performance of the Mk. 100 is demonstrated by the fact that, although the maximum still-air range is 5500 miles and the full volumetric payload can be carried over a range of 4000 miles, direct operating costs for ranges as short as 500 miles are low enough to be competitive with those of much smaller craft. In the Mk. 200, 250 and 300 aircraft, greater payload and higher speed have been achieved, it is stated, for equivalent ranges, while operating costs have again been reduced.

The first prototype aircraft made its maiden flight on August 16, 1952, and has since been engaged upon a rigorous test schedule. Originally having a power installation of four Bristol "Proteus 600" series engines the aircraft has now been fitted with "Proteus 705" engines. The all-up weight is 130,000 lb, compared with 140,000 lb for the production Mk. 100 and 155,000 lb for Mks. 200, 250 and 300.

The Mk. 100 has an all-up weight of 140,000 lb and with its maximum payload of 25,000 lb has a still-air range of 4000 miles. Its maximum still-air range is 5500 miles when the payload is reduced to 12,000 lb. With a cruising speed of 360 m.p.h. it is the fastest propeller-engined civil aircraft in the world. The aircraft has a span of 140ft and is 114ft long. The later versions will have an all-up weight of 155,000 lb, the capacity payload increases to 30,000 lb, and the maximum range becomes 5100 miles with 20,000 lb payload.

The Bristol "Rotorcoach," or Type 173, is the first twin-engined helicopter in the world so arranged that both rotors can be driven by either engine. It is being developed as a short-range transport for fourteen to sixteen passengers, but is also capable of filling a number of military roles. It can be readily converted to carry 3000 lb of freight, the four-wheel undercarriage providing a level loading attitude, or can be used as a "crane," lifting still greater weights over very short distances by slinging the loads from an external beam below the fuselage.

The "Rotorcoach" made its maiden flight on January 3, 1952, and has since completed a considerable amount of test and development flying. The machine appearing in the display (Fig. 23) is the second prototype, which flew for the first time in May this year.

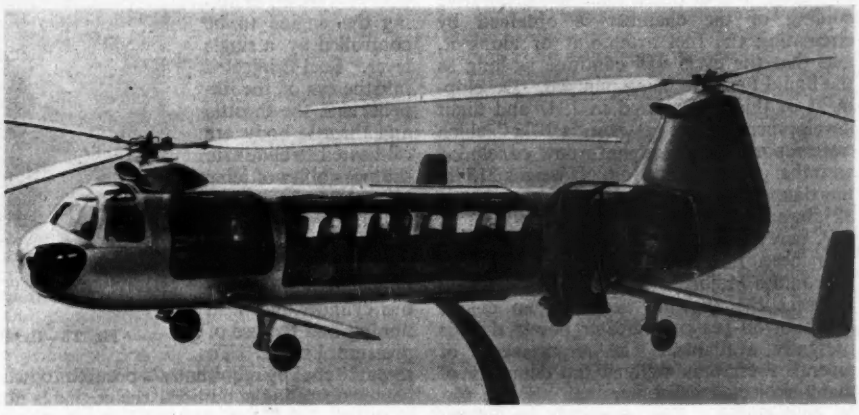


Fig. 23—Model of the Bristol "Rotorcoach"

It is fitted with stub wings of the kind to be embodied in three Mk. 3 machines which, powered by 850 b.h.p. Alvis "Leonides Major" engines, have been ordered for the development of commercial services.

The main rotor diameter of the Mk. 3 is 48ft 7in, which will operate with a disc loading with an all-up weight of 13,500 lb of 3·63 lb per square foot. The aircraft will have a top speed of 153 m.p.h. and its most economical cruising speed will be 138 m.p.h. Its rate of climb on one engine is 120ft per minute.

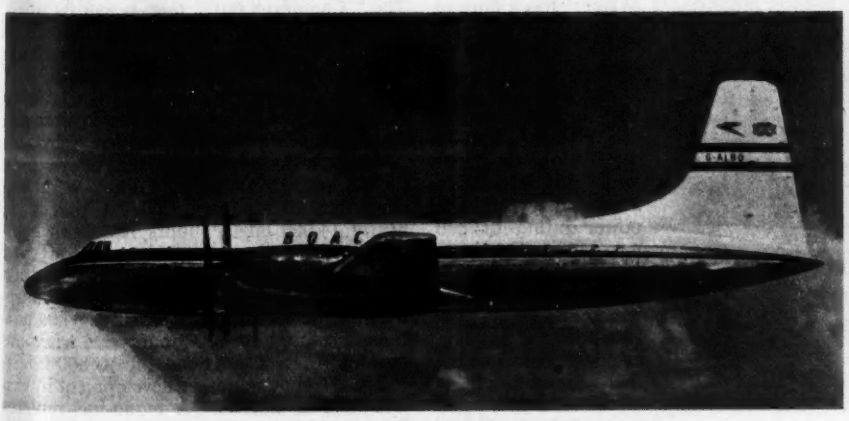


Fig. 22—The Bristol "Britannia" Propeller-Turbine Airliner

Engines

Last week our report on this section of the static exhibition concluded with a description of some rocket motor developments, and is continued herewith.

The other application of the rocket motor to which we referred follows from the fact that as it carries its own supply of oxygen it is independent of its environment and can therefore operate at very high altitudes where the thrust per weight ratio of the gas turbine becomes very low In this form it is used as the

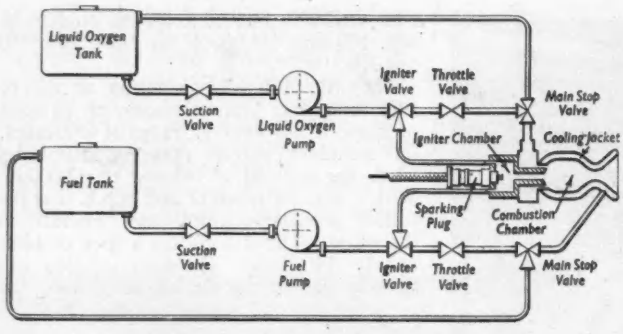


Fig. 24—Diagrammatic Arrangement of the "Snarler"

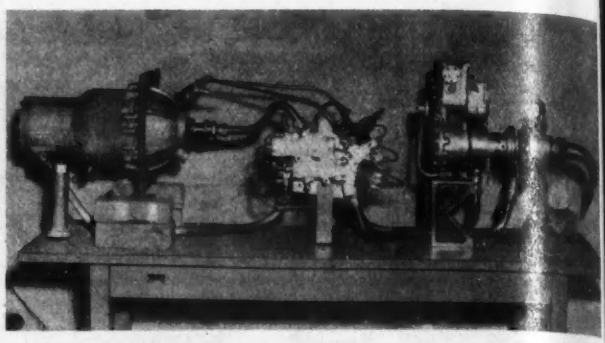


Fig. 25—The Armstrong Siddeley "Snarler" Rocket Motor

prime mover and to increase its endurance it is fitted with independent turbo-propellant pumps consuming identical fuels. Such units were used in some German wartime aircraft and are fitted to at least one American supersonic research aircraft.

In this country no details can yet be disclosed of developments in this category, apart from details which have already been published of the "Snarler" unit, which is being exhibited by Armstrong Siddeley Motors, Ltd.

This unit develops 2000 lb thrust and has a throttle control. About the choice of oxidant there is considerable diversity of opinion and it is maintained by this company that liquid oxygen is the most suitable. The cycle is shown purely diagrammatically in Fig. 24 and the unit is illustrated in Fig. 25 It will be noted that the regenerative cooling of the chamber is obtained by circulating the fuel around it or along it, and that the cycle will continue as long as the liquid fuels are being pumped. Development of this unit started in 1947 and flight developments in the Hawker "P1072" which were reported last year have now concluded with this particular version. It weighs 215 lb, the diameter of the combustion chamber is 12·5in and its length 23·4in.

A new double-row radial engine has this year been introduced by Alvis, Ltd., the "Leonides Major," which has been designed to meet the growing need for an engine of about 50 per cent greater power than is presently available. The requirements of several aircraft as well as the demands of many projected helicopters can now be met by this engine. One characteristic of the larger engine when compared with the "Leonides" is the reduction in outside diameter from 41½in to 39in. The smaller nacelle resulting will enable a better installation to be made in orthodox aircraft, and in the case of helicopters of the multi-engined variety where the engines are situated between the compartments occupied by the pilot and the crew or passengers, this will allow of easier intercommunication in the rather narrow fuselages usually typical of this type of aircraft. The engine can be arranged for operation with the crankshaft in the vertical, horizontal or intermediate planes.

The "Leonides Major" (Fig. 26) is a fourteen-cylinder air-cooled, two-row radial unit with push rods operating overhead poppet valves. It has an outside diameter of 39in, and is equipped with a supercharger and a reduction gear of 0·533 to 1 ratio for the propeller driving shaft. It has a low pressure fuel injection system, enabling the engine to be controlled by a single lever. Fuel is injected into the eye of the impeller and the throttle and throttle body are oil heated to eliminate the possibility of icing in the induction. Satisfactory cooling for long taxi-ing and extended climb is obtained by more generous cylinder and head finning and the use of pressure baffles. To meet the cooling requirements peculiar to helicopter operating conditions the engine is not normally fitted with a reduction gear but is equipped with a clutch and cooling fan mounted immediately above the timing case front cover plate. The engine has been designed to operate in either the horizontal or vertical or intermediate planes for helicopter operation without any major conversion parts being necessary.

The "Leonides Major" has a bore of 4·8in, a stroke of 4·41in, a capacity of 1117·8 cubic inches, a diameter of 39in, and in the case of the vertical helicopter application is 55in long. This version has a maximum 5 minute power rating of 870 h.p. at 3000 r.p.m. and 8 lb boost and it weighs 960 lb. The maximum weak mixture rating is 515 h.p. at zero boost when the fuel consumption is given at 0·525/0·555 pints per brake horsepower per hour.

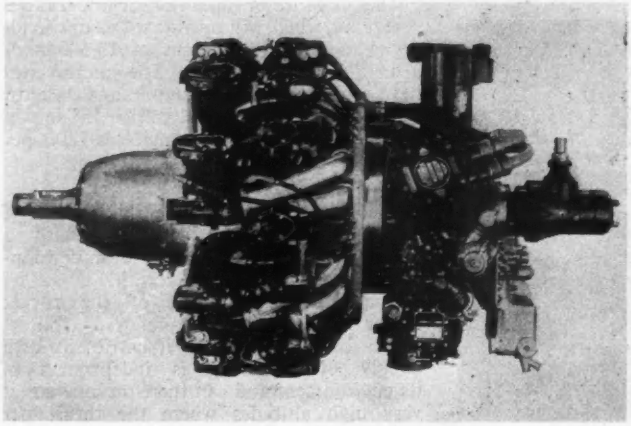


Fig. 26—The Alvis "Leonides Major"

Displayed by the Bristol Aeroplane Company, Ltd., was the "Centaurus 661" eighteen-cylinder double-row radial engine which powers British European Airways Elizabethan class "Ambassador" airliners, and the company has published an impressive account of its reliability. Analysis of its operational record reveals that up to June 30th a total of 40,250 engine flying hours had been completed by the Elizabethan fleet and 91 per cent running had been achieved on a life average of 530 hours per engine. To June 30th fifty-three routine engine changes had been made and only two changes were called for as a result of engine faults. The company believes that for an engine making its début in civil airline service it is doubtful if this performance has ever been bettered by any other engine during initial civil operation.

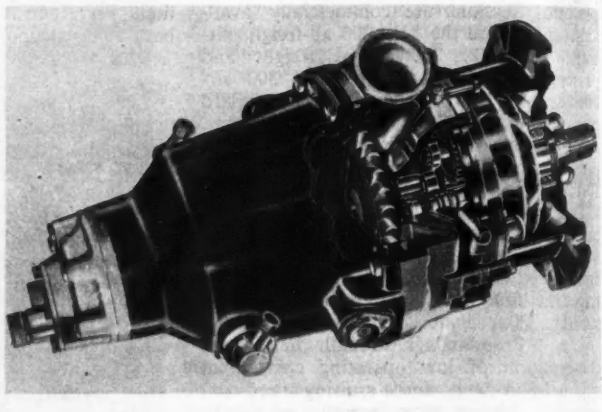


Fig. 27—The Plessey Liquid Fuel Turbine Motor Starting Unit

The first Elizabethan airliner was delivered to B.E.A. in September, 1951, and scheduled flying on the London-Paris route was inaugurated on June 16th last year with the re-opening of the Silver-Wing Luxury Service. The "Centaurus 661" then began its career in civil operation with the modest inter-overhaul "life" of 300 hours and within a few months the inter-overhaul period had been doubled to 600 hours. In a letter to the Air Registration Board the Project and Development Branch of British European Airways expressed the view that efforts for a further trial extension in "life" were well supported by the fact that, at that time, nearly 14,000 engine hours had been completed with Elizabethan class aircraft and that only one engine failure had been experienced during that period. The inter-overhaul period of the "Centaurus" has now been increased to 700 hours and trials are now in progress to extend life to 800 hours.

Fig. 27 shows another development in gas-turbo engine starters. A mono-fuel replaces the cartridges used in the Plessey unit described in our issue, December 22, 1950.

Mechanising Colonial Agriculture*

By J. E. MAYNE, A.M.I.B.A.E.

The Colonies import about £5,000,000 worth of agricultural machinery a year, more than half of which goes to East Africa. In this paper the author reviews some of the technical and commercial problems associated with the mechanisation of Colonial agriculture.

THE Colonial Territories cover 2,000,000 square miles and contain 66,500,000 people. The most valuable products are sugar, cocoa, cotton, groundnuts, rubber, vegetable oils and sisal. Amongst the locally-produced food crops, rice is gaining in importance in both flood and "dry" areas. Other cereals include wheat, sorghum, millets; many pulses are grown, and in some areas the main food supply is bananas, or root crops such as yams, cassava, and sweet potatoes. The agricultural conditions within the Colonies vary from tropical swamps at sea level to wide open wheat growing uplands at 8000ft elevation.

At present, much attention is being given to the African territories which comprise three-quarters of the land area of our Colonies and five-sixths of the people. Africa as a whole is the least mechanised continent, having less than 1 per cent of the world's tractors on 12 per cent of all arable land. Some years ago it was estimated that in tropical Africa 50,000,000 people cultivate 100,000,000 acres, of which one-quarter were thought to be suitable for mechanisation. This would provide a market for 30,000 tractors per year, one-tenth of Europe's total production. A very rough estimate puts the number of tractors in use in Colonial agriculture at 20,000; recent imports of tractors and agricultural machinery into the Colonies are shown below :—

	£
1938	378,600
1947	3,187,000
1949	7,305,400
1950	5,273,500

The fall in expenditure in 1950 is largely accounted for by reduced spending in East Africa, probably resulting from the retrenchment of the groundnuts scheme and the stiffening of currency control. In 1947 East and Central Africa bought £403,000 worth of equipment from Britain and £1,500,000 from the U.S.A., while in 1950 approximately £1,500,000 worth was bought from both sources.

Economic

Sufficient experience has now been gained in several Colonies to show that the cost of operating tractors under the local conditions is very much higher than had been expected. Unfortunately, very few costs analyses have been published; but there are many records in existence. The reluctance of tractor owners to publish their costs is probably due to the fact that "a paragraph could be written on each machine" in explanation of high operating costs; but it is just this very fact that makes the information so valuable. Every tractor has its individual story; but collectively, as more records are assembled, a pattern will emerge. The main function of tractors in the Colonies to-day is to plough the land and to prepare it for planting. Timeliness is often the objective, and even the African peasant farmers in some areas are prepared to pay high charges for tractor ploughing. In one part of Tanganyika local chiefs have charged one ox per acre when the Government rate in the same area was 40s., and the value of oxen (in a far distant market) was about £25. A review of the costs of many tractors operated by various forms of Government authority in several Colonies shows that 40s. is about the lowest "economic" charge one could possibly make for ploughing African peasant land by the acre. This appears to be general throughout East and Central Africa. In several ploughing schemes the cost is considerably higher than 40s. News of these charges has caused considerable interest amongst some of the tractor manufacturers, because if costs are likely to continue at this high level the future for tractor operations (other than urgent cultivations) does not seem very bright, especially in territories where labour is relatively cheap, even if not abundant.

An analysis of records from the Rhodesias, Nyasaland, Tanganyika and the Sudan shows the cost of operating a theoretical "average" tractor in the backwoods of Africa to be made up roughly as shown in the accompanying table.

Cost Analysis for an "Average" African Tractor

	£ s. d.
Depreciation: On the assumption that the tractor will be written off over a generous life of seven years and cost, initially, £700; depreciation per annum	100 0 0
Interest on capital, say, 2 per cent of depreciating value over seven years (i.e. 2 per cent of £350), per annum	7 0 0
Spare parts and repairs, taking major overhauls into consideration, per annum	270 0 0
Fuel (including small allowance for waste and pilferage)	100 12 0
Other supplies	16 6 0
Wages:	
Driver, twelve months at 50s.	£30 0s. 0d.
Assistant (at half pay)	£15 0s. 0d.
	45 0 0
	£538 18 0

Number of hours recorded as worked	800
Cost per hour	13s. 6d.
Number of hours actually spent in useful work	500
Cost per hour	22s.

It will be seen that expenditure on fuel, lubricants, and wages are comparatively low compared with the cost of replacements and repairs. Although there is undoubtedly room for improvement of tractor operation in the tropics, there is a much greater need for a reduction in the cost of repairs and of spare parts delivered to the user. The charges for repairs are high owing to (*a*) the shortage of competent mechanics in the Colonies; (*b*) the extraordinary high wages paid to expatriate mechanics, and (*c*) the travelling and subsistence costs of mechanics in the field. It is important that the shortage of reasonably-priced men be overcome as soon as possible; and if we are not yet equal to the task of training our own people in our own Colonies we should, perhaps, be realistic enough to rely on Italian, Greek or Asian immigrants who may undertake the work at economic wages.

Technical Problems

At the moment, technical problems do not predominate. A machine can be found, from either sterling or dollar sources, for almost every normal operation in Colonial agriculture for which mechanisation is desirable. Perhaps the greatest strides have been made in rice cultivations, and in the provision by British manufacturers of a good range of disc ploughs and implements of cultivation.

Rice Cultivation.—Large-scale operations have been in progress for some time in British Guiana and experiments have been carried out in Malaya over a number of years. Smaller programmes of production and investigation have been going on in other Colonies. The conditions under which rice is grown are extremely varied, but at least it can be said that the answers are now known as regards certain conditions. In deep peat swamps with no firm bottom, which may contain submerged timbers, mechanisation is—for the present—out of the question. In mangrove swamps experiments in clearing are proceeding. In both peat and mangrove swamps the "Water Buffalo" tractor may have a part to play in large rice production schemes, but it is too early to say. It is difficult to see how machines might be put to work on some of the tidal flood lands upon which rice is grown.

On most other types of paddy land one form of tractor or other has worked successfully. The most important operations for mechanisation are the cultivations, and these can now be performed either on dry land or on flooded land (but imperfectly on land which is only partly flooded). Tractor adhesion is gained either by the penetration method which is effective when shallow mud covers a firm subsoil, or by flotation which depends on the use of over-size tyres, drum wheels, cage wheels, or double wheels. Owing to the "pushing" action of its rotor, the rotary hoe is very successful on small and medium rice farms, although on extensive production schemes its work is probably too exacting and slow. If it is not possible to control the flooding of paddy land, it is essential for the mechanised rice farmer to know when to expect the water and how it will behave when it comes.

Disc Implements.—In the old-established farming areas of many Colonies, mouldboard ploughing is gaining in popularity; but the general need is still for disc implements—and will continue to be so indefinitely. Serious shortages of disc ploughs and cultivators which threatened the Colonies owing to the restriction of dollar spending have largely been averted by several British manufacturers who have undertaken the production of whole ranges of new disc equipment to meet the needs of the sterling area. A very recent, and very welcome, arrival is a disc ridger built in South Africa. Standard mouldboard ridgers are inadequate for use in the tropics for various reasons, and disc ridgers have long been awaited. As field experiments gradually yield more information about the effects of ridge size, and crop spacing, for various Colonial crops, it might be possible to standardise field practices so that tractor ridging could be extended into new areas. At this point the economists must take over.

Tie-Ridging.—Another problem associated with ridging is tie-ridging (or, in some areas, basin-listing). The value of tie-ridging in certain circumstances has been conclusively proved in field experiments, but the translation of significant experimental results into a machine for Colonial conditions has not yet been seriously attempted, although the manager of one of the unit farms of the Overseas Food Corporation, Urambo, has devised a machine which is adequate for use on his farm. Unfortunately, basic data are still lacking, as are signs of co-ordinated work which might lead to general conclusions about tie-ridging as affecting whole regions. The present evidence is insufficient to justify exploratory machine development. A further series of trials is necessary to determine optimum and "acceptable" standards of ridge size, spacing and shape, and of frequency and size of ties. Furthermore, the question of weed control on tied land should be fully investigated before recommendations are made for the development of a tieing machine.

Toolbar Clearance.—One of the outstanding features of British wheel tractor design since the war has been the steady extension of the system of direct-coupling implements to the tractor. In many overseas markets this principle has been very popular and the implements now available for direct attachment include such new arrivals as a three-furrow stump-jump disc plough, a one-way disc tiller, a two-row tobacco ridger, and maize planter. The clearance of British row-crop tractors is in general adequate, but greater toolbar clearance is needed for certain operations (e.g. inter-row tillage in maize). Further work on pest control will probably show that greater clearance is necessary for tractor-mounted spray booms if the sprays are to be effective at the tips of the growing plants in the tropics.

Tractor Weight and Power.—Tractor studies in the Colonies have not yet been extensive and exhaustive. The tendency has been to establish mechanisation projects under the various titles of "pilot scheme," "mechanised crop production project" or "tractor ploughing investigation," but with a specific local end in view. Usually the purpose is to introduce mechanisation to a new area and to see how it goes. The tractors and equipment are usually selected in advance and the investigation seldom begins with the recording of basic technical data such as soil resistances and the comparative preformances of various types of tractor under local conditions. In other words, these investigations have a severely practical purpose and many of them are only experiments in so far as they are "tryouts" which might fail. Nevertheless, the sum

* *Journal Institution of British Agricultural Engineers*, July 1953. Abstract.

total of experience being gained in the Colonies is very considerable, and with this as background it would now be possible to plan a very comprehensive programme of testing and recording for the future. Particular attention should now be given to the comparison of the performance and economics of light wheel tractors (25–35 b.h.p.) as against the " heavies " (40–50 b.h.p.), and to the long-term advisability of using diesel tractors in areas where facilities for fuelling, supervision and maintenance are very primitive.

Tractor Width.—The problem of whether to attempt to straddle tall crops, such as sugar cane and maize, or to pass between the rows, appears to have settled itself with a little help from the engineers. By providing a number of narrow tractors, and narrow versions of standard tractors, they have made it possible for any grower of crops in rows 6ft apart, or more, to get a machine which will pass through the crop. Growers, for their part, have shown themselves perfectly willing to plant their crops in wider rows than they have been accustomed to in order to accommodate a tractor—thus, we have seen the planting of sugar cane in 6ft rows in the West Indies, and elsewhere, to admit a rotary hoe, and the growing of maize in the Rhodesias in rows as wide as 7ft 6in through which standard tractors can pass. Many maize growers maintain that all inter-row cultivation should have been completed before the fast-growing crop has become too high for a row-crop tractor to straddle.

Where Tractors Cannot Enter.—In some territories peasant farmers produce crops in places which are beyond the reach of ordinary tractors. An excellent example of this is to be seen in Basutoland, where a primitive form of wheat cultivation is carried out on mountainsides and plateaux which are accessible only on foot or by pony. A mechanised project is about to be established in the lowlands, but the pack pony remains the only mode of ingress to the mountain area. Animal draft can be used for cultivations in these circumstances, but the laborious and wasteful practices of bull-mashing and wind winnowing are the only means of threshing and clearing the crop. Officials of the local Agriculture Department are convinced that a small rudimentary threshing machine and a separate winnower, with an output of about 4 cwt of grain per hour, could be put to work in the mountains with great benefit to the people. The whole equipment would have to be collapsible for packing on ponies, and the source of power would be animal, through a suitable rotary gear.

Commercial Problems

Undoubtedly, the greatest commercial problem is the finding (or creating) of local representatives for the manufacturers. The Colonial market for agricultural machinery has never been very great, and it must be admitted that there is no immediate prospect of it expanding rapidly. The process will be slow and measured. The number of local firms interested in the business is therefore small, and to them agricultural engineering can only be a sideline. In Kenya, one of our most advanced Colonies with a " large " European population on the land, the market for the more complicated machines consists of less than 3000 farmers dispersed over thousands of square miles in various conditions and forms of agriculture. In these circumstances, when faced with a choice of machines, the farmer buys where he will get best after-sales service.

The problem of service is made more difficult by the fact that several British, American and, possibly, Continental manufacturers are likely to be represented in a territory whose consumption —whatever the future may portend—is at present very small. One finds, therefore, diverse machines and diverse standards of service, with the reputation of manufacturers in general suffering as a result of the inadequacy of the less capable agents. The psychological importance of this may not be fully realised in this country, where agriculture is served by a busy, thriving community of traders and specialists ; but in a Colony all the trade in agricultural machinery may be done by a mere handful of individuals whose first-hand experience of agricultural equipment may be nil.

Coal Versus Oil

(By our American Correspondent)

While the coming winter may once more force Britain to import coal in order to alleviate the fuel shortage, the very opposite development has taken place in the United States. Since the beginning of this century coal has had to face the growing importance of other fuels in America, and now official statistics show that, for the first time, oil has supplanted coal as the country's chief fuel. Unfortunately, this progressive decline in the importance of coal has resulted in abandoned mines, idle miners, sale of coal at a loss, and a rise in output by non-union mines, whose owners endeavour to " get out of the red " by cutting the high labour standards built up by the United Mine Workers under the leadership of John L. Lewis. The worst aspect of this record is that it comes at a time when the rest of the national economy is enjoying full employment and full production. If a business recession should cause a slackening in the steel and other basic industries later this year, the depression in the coal mining industry is likely to become even more acute and more mine whistles will toot the single blast that means " no work to-day."

Anthracite has been much harder hit than bituminous coal. Despite feverish efforts by some of the large producers to revive interest among home owners in burning anthracite in their furnaces, the market is disappearing at a rate that holds out little promise of any improvement, even on a long-term basis. The hard coal mines of North-East Pennsylvania, which produced 99,612,000 tons of anthracite in 1917, their peak year, were down to 39,974,000 tons last year. Production during the first half of this year was 27 per cent below last year's level. Maintaining the same rate of output for the rest of the year would mean a 1953 total of less than 30,000,000 tons. Soft coal, which has its primary use as an industrial fuel, has not experienced the same precipitous drop. The industry, which had a peak production of 630,623,000 tons in 1947, was down to 465,000,000 tons last year. This was 68,664,000 tons below the 1951 output. So far this year the mines have turned out 7·7 per cent less coal than they did in 1951, even though the national steel strike had sharply reduced the demand for coal in June and July of last year. A few optimists in the industry feel that coal orders will still rise sufficiently to bring the year's production of bituminous coal to 450,000,000 tons, but most analysts are convinced the total will not go beyond 430,000,000. All these calculations are made without taking into account the possibility of a new mine strike this year. Mr. Lewis had the right to notify the mine operators that he wants to terminate his present wage agreement, which comes to a close on September 30th. He has given no indication of his plans, and the industry hopes that he will elect to let the contract carry on into the next year without changes in its wage or welfare provisions. A few operators want to take the offensive and serve notice on the union leader that labour costs must come down, but the great majority of the owners will be content to maintain the *status quo* if Mr. Lewis avoids any pressure for higher wages or other contract improvements. The employers are certainly not likely to agree at this time to any new wage increases in view of the difficulties which they encountered in the past trying to pass along higher labour costs in the form of higher coal prices. Since December, 1950, the bituminous coal producers have had to absorb two wage increases—one of 1·60 dollars a day and the second of 1·90 dollars, accompanied by an increase of 10 cents a ton in so-called welfare royalties and a substantial rise in freight rates. In the meantime they have had an increase of only 2 per cent in the prices they were able to get from their customers.

There is one important factor which may influence Mr. Lewis not to seek another pay rise from the employers at this time : the majority of American miners are not now taking home any more money in their wage envelopes than they did before they got either of their last two increases. In December, 1950, the average anthracite miner was earning 1·98 dollars an hour, but he worked enough hours to bring his weekly pay to 65·14 dollars. In September, 1952, his hourly average was up to 2·25 dollars and his weekly average to 76·73 dollars. But in April of this year, with the hourly rate up to 2·45 dollars, the weekly average had dropped to 61·99 dollars because of a shorter working week. The question Mr. Lewis will have to decide is whether another rise in hourly rates will enhance or reduce earning opportunities for his members. Whatever he does he will have to reckon with the declining importance of coal in the total energy picture. Statistics compiled by the U.S. Bureau of Mines showed that coal accounted for 34 per cent of the units of energy consumed in America last year, compared with 39·4 per cent for crude oil, 22·5 per cent for natural gas, and 4·1 per cent for water power. At the beginning of this century coal provided nearly nine-tenths of all the energy consumed in the United States. There has, of course, been a vast expansion in the use of all forms of power since that time, but coal has been largely eliminated by oil and natural gas in the race to take advantage of this expanded demand. Part of the problem has been created by the import of residual oil from Venezuela and other foreign countries. The coal mine operators and the miners' union have joined forces in urging Congress to limit such imports to 5 per cent of the total domestic demand for oil, but even if this Bill passes, it will not restore coal to the important position it used to enjoy. Coal has lost ground particularly in the field of railway fuels—due to the growing substitution of diesel engines for steam locomotives, the demand for soft coal used by the railways has been reduced by 75 per cent. The development of a successful coal-burning gas turbine locomotive might, however, do much to counteract the present trend, and the mine-owners are following with close interest the work which is currently being done in this field by the Locomotive Development Committee at Dunkirk, New York.

American Engineering News

(By Our American Correspondent)

Applications of Radiant Glass Heating Panels

Because radiant glass heating panels have recently come into increasing use in America for the heating of dwellings and other small buildings, the U.S. Housing and Home Finance Agency sponsored a research programme at the National Bureau of Standards aimed at testing these panels under controlled conditions. The results of these tests have indicated that electrically heated radiant glass panels constitute a satisfactory method of warming a house without a basement. However, even with the house thoroughly insulated, electric heating can be expected to entail higher annual heating costs in most areas than would coal, oil or gas, because the useful heat derived from electricity has a higher unit cost than that produced from these common

fuels. The tests involved were conducted in the N.B.S. test bungalow, a small single-storey house comprising three rooms, a kitchen and a bathroom, with a hall near the middle of the structure connecting the rooms. For the purposes of these tests the house was treated as "basementless." The test bungalow is completely enclosed in an insulated structure with a 5ft space between the outside bungalow walls and the inner walls of the enclosure. Unit coolers mounted in the enclosure allow the control of the outdoor temperatures. Thermo-couples, suspended at various levels throughout the house, were used with indicating and recording equipment to observe the temperature distribution in the house.

A representative radiant glass panel is mounted on a metal frame and is backed by a reflective shield from which it is separated by a small air space. A metallic coating on the rear surface of the glass serves as the electric conductor and heating element. The output per panel is generally about 1000W, although units with lower wattage ratings are available from some manufacturers. The panels are designed for either 115V or 230V alternating current and are made for mounting beneath windows, as baseboard units, or as vertical units adjacent to the window frames. Heat is transmitted from the glass heating panels primarily by radiation and convection. When the panel is heated above the room air temperature, heated air passes upward over the face of the panel, through the space between the glass and the reflective shield, and between the shield and the frame of the panel assembly. At the same time, radiant heat is emitted outward from the face of the panel. The passage of air through the spaces at the back of the glass keeps the temperature of the rear of the assembly cool enough to allow it to be in contact with combustible materials. For some of the tests the bungalow was insulated with 3½in of rock wool laid on the upper side of the ceiling of the living quarters and 1in of rigid fibre-board insulation nailed to the bottom of the floor joints. The bungalow with this amount of insulation was considered as "uninsulated." For the remainder of the tests, the stud spaces of the walls of the bungalow were filled with expanded mica insulation, and plastic-filled wire mesh screen cloth was tacked over the outside of the window frames to simulate the storm windows, which are popular in the United States. With this additional insulation the house was considered "insulated." Ten radiant glass heating panels were installed in the test bungalow at the beginning of the tests. Two of them were placed under the double window of the living-room, one under the single window of the living-room, and one under each of the other windows of the bungalow, making a total of three panels in the living-room, two in the kitchen, two in the north bedroom, two in the south bedroom, and one in the bathroom, all being situated just above the floor level. The panels had a rating of 1000W at 230V, but were actually operated on a 208V power supply, corresponding to a capacity of approximately 820W. The panels in each room were connected to separate electrical circuits and the room temperature of each room was controlled by means of an individual thermostat and relay. The initial power demand for the panels was about 145 per cent of the steady demand after the panels became thoroughly heated. The panels required approximately twenty minutes after starting to attain a steady power demand and approximately thirty minutes to attain a steady temperature on their exposed glass surfaces. The temperatures at the centre of the glass plates when operating at the rated voltage averaged about 340 deg. Fah.

The temperatures observed in the test bungalow for eleven different test conditions with constant outdoor temperatures in the range from 0 deg. to 32 deg. Fah. showed that the vertical temperature differences in the "living" zone (considered to extend from 2in to 60in above the floor) were moderately low, ranging from 3·5 deg. Fah. for an outdoor temperature of 32 deg. to 7·0 deg. Fah. for an outdoor temperature of 0 deg. Fah. Thus, the temperature gradient in the living zone was 0·7 deg. Fah. per foot of height at the higher outdoor temperature and 1·4 deg. Fah. per foot of height at the lower outdoor temperature. The average gradient from floor to ceiling was a little lower than in the living zone, ranging from 0·6 deg. Fah. per foot for an outdoor temperature of 32 deg. to 1·1 deg. Fah. per foot for an outdoor temperature of 0 deg. Fah. The vertical temperature differences in the living zone with the radiant glass panels were about 1 deg. to 2 deg. Fah. greater than those observed in the same house with a baseboard convector heating system. Insulating the walls and adding the storm windows did not significantly change the vertical temperature differences observed in this house. Since the same number of panels were in operation in the insulated and uninsulated condition of the house, the percentage of time during which the heaters were energised was appreciably less in the insulated house. Consequently, the chimney effect of the house and natural convection played a more significant part in the insulated house during the longer periods when the heaters were not energised than they did in the uninsulated house.

The average horizontal temperature variation between stations of observation within the individual rooms was 1·6 deg. Fah. for an outdoor temperature of 32 deg. Fah. and 2·6 deg. Fah. for an outdoor temperature of 0 deg. Fah. when the differences at all five levels of observation were averaged together for each room. However, the horizontal temperature differences within the rooms were consistently greater at levels of 2in and 30in above the floor than at the higher levels of observation, since the electric panels were situated below the 30in level and emitted more radiant heat to some of the thermo-couples than to others. The maximum horizontal temperature difference between rooms was 1·6 deg. Fah. for an outdoor temperature of 32 deg. Fah. and 2·5 deg. Fah. for an outdoor temperature of 0 deg. Fah. when all levels of observation were considered in computation of the average. The greatest variations between rooms usually occurred at levels of 2in and 60in above the floor. Insulating the walls and adding storm windows did not significantly change the horizontal temperature variations within rooms and between rooms. The heat loss of the test bungalow was 8·33kW at an outdoor temperature of 0 deg. Fah. when the walls were uninsulated and 5·18kW when the walls were insulated. Because the line voltage was only 208V, the ten panels installed in the test bungalow consumed only 8·2kW of electric power, and since the installed capacity did not exactly equal the heat loss on a room-by-room basis, some of the rooms of the uninsulated house were slightly underheated at an outside temperature of 0 deg. Fah. The relation between this heat loss and the indoor-outdoor temperature difference was linear. The ratio of the heat loss of the insulated structure to that of the uninsulated structure was 62 per cent for an outdoor temperature of 0 deg. Fah. and 66 per cent for an outdoor temperature of 32 deg. Fah.

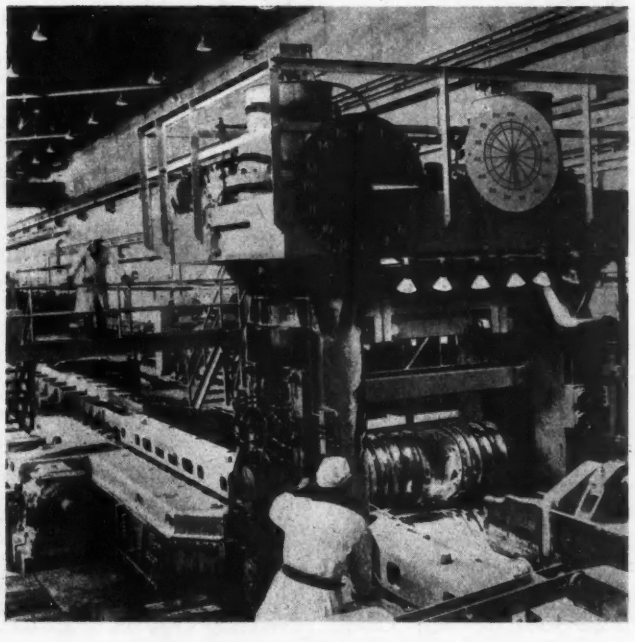
An attempt was made to heat the insulated house with six panels at an outdoor temperature of 0 deg. Fah., using two panels in the living-room and one each in the other four smaller rooms. Some of the rooms were found to be underheated because the heat loss of a particular room exceeded the installed heating capacity of that room. The results indicated the desirability of having heating units of lower and intermediate wattage capacity to facilitate the heating of small rooms. The radiant panels in the uninsulated bungalow were compared under identical conditions with a forced warm-air heating system, using baseboard registers, the vanes of which directed the warm air down at the floor. The comparison showed that the radiant system provided more radiant energy at the 30in level and more comfort at the floor level.

The effect of lowering and raising the thermostat setting was determined with regard to both temperature pick-up and power demands. From the data accumulated it appeared that in the insulated house, when all ten panels were utilised, one hour was required to raise the room temperatures from 65 deg. to 70 deg. Fah. at an outside temperature of 0 deg. Fah. An analysis of the tests indicated that compensated room thermostats with very low differential, which produce rapid cycling of the heating units, are desirable for use in conjunction with radiant glass heating panels. Their use tends to provide a continuous emission of radiant heat; the cessation of radiation between heating cycles was quite noticeable when the "off" period of the thermostat was of long duration.

One design of glass panel was subjected to thermal shock tests simulating hazards that might occur in use, such as rain coming through a window or shower spray in the bathroom. The main effect of the treatment was an increase in power demanded by the panel due to the cooling action of the water. Mechanical shock tests showed that the principal weakness was in resistance to shock around the edges. The results of these tests indicate that electrically heated radiant glass panels constitute a satisfactory method of warming a well-insulated "basementless" house from the standpoint of temperature gradients in the vertical and horizontal directions, floor temperatures and general comfort. It has been found that the accepted methods for the calculation of the heat loss of a house may be used in the determination of the total capacity of the heating units required. The total energy required to produce a desired condition of warmth may be slightly less with electric panels than with more conventional heating units because of the absence of piping or duct heat losses, because the reverse heat losses from the heating elements are lower, and because the individual room thermostats can more readily prevent the overheating of any of the rooms.

A Uranium Rolling Mill

The accompanying illustration shows what is believed to be the first rolling mill in the world specifically designed and built for the hot rolling of uranium ingots into bars. The bars are fabricated into slugs which are used in nuclear reactors. The unit is a reversing two-high blooming mill equipped with conventional manipulator tables and was designed and made by the Birdsboro Steel Foundry and Machine Com-



Rolling Mill for Uranium Bars

pany, of Birdsboro, Pennsylvania. The mill is now in operation at the Feed Materials Production Centre of the U.S. Atomic Energy Commission at Fernald, Ohio, which is a completely integrated series of works whose function is to convert raw uranium ore into highly pure uranium metal in various shapes. The processes employed have been designed so as to reclaim essentially all of the uranium contained in the ores, and also a substantial portion of the chemicals used in various process steps. Among the intermediate products produced at the centre are "orange oxide" (UO_3), "green salt" (UF_4), and metal ingots, rods and slugs. These compounds and metal parts are used in the production of fissionable materials and other isotopes in the atomic reactors of the A.E.C. at Savannah River, and Hanford, Washington, or in the gaseous diffusion separation plants at Oak Ridge, Tennessee, and Paducah, Kentucky.

An Elevated Highway Structure in Manhattan

With the approaching completion of the South Street Elevated Highway in New York City, it will be possible for the motorist to drive almost all of the 24 miles around the perimeter of Manhattan on dual express roads which are nearly free of traffic lights. The South Street viaduct, which is 1·6 miles long, runs in a south-westerly direction toward the tip of Manhattan and will connect the Franklin D. Roosevelt Drive along the East River with the Battery Park Underpass. Through its connection with the Brooklyn Battery Tunnel and a turn-off ramp at the Brooklyn Bridge, the structure will relieve one of the worst traffic bottle necks of New York City. The principal reason for the congestion in this area is the operation of the Fulton Fish Market, whose merchants rent a considerable section of the public street.

The accompanying illustration shows a part of the steel structure, situated underneath the Manhattan Bridge, in the course of erection. The structure, which is being fabricated and erected by the Bethlehem Steel Company, comprises ninety spans and will contain altogether some 14,000 tons of steel. The foundations required 14in by 117 lb per foot H-section steel piles to be driven to rock at depths ranging from 35ft to over 200ft, with the number of piles per footing varying from three to eleven. The superstructure rests on two-column bents having a transverse span of 35ft between columns and having 18ft and 22ft cantilever overhangs making up an overall width of 75ft. The highway follows the waterfront as much as possible to avoid cutting off light and air from shops and apartment buildings on the west side of South Street. Its 75ft width comprises two 33ft roadways which are separated by a 4ft central reservation. The remaining 5ft are shared by two safety walks, situated on each side of the viaduct. The pavement consists of 1½in of asphalt laid directly on a concrete slab 8in thick.

In accordance with the efforts of the borough engineers aiming at "making Manhattan modern," the viaduct was given a simple design with smooth-flowing curves and without the "gingerbread" which was popular twenty-five years ago, when the West Side Highway of Manhattan was built. The value of the road ringing Manhattan is illustrated by the fact that the West Side Highway now handles a total of 99,000 vehicles during a twenty-four-hour weekday period. At peak load 7029 vehicles pass over the highway per hour. The Franklin D. Roosevelt Drive along the East Side is used by 68,000 vehicles on Sunday and by 57,000 vehicles on weekdays. Its peak load is 4148 vehicles per hour.

Erection of South Street Elevated Highway

A Large Tractor Bulldozer

The large tractor bulldozer which is shown in the accompanying illustration, was recently delivered by the Allis-Chalmers Manufacturing Company, of Milwaukee, Wisconsin, to the U.S. Army Corps of Engineers for testing at the Research and Development Laboratory, Fort Belvoir, Virginia. The four-wheel, rubber-tyred tractor is intended as a high-speed, heavy-duty prime mover for artillery and scraper equipment. The vehicle is 11ft 7½in high, 22ft 9in long, and weighs 51,300 lb. The bulldozer blade itself is 11ft wide and 4ft high. Since speed and manœuvrability were considered essential, the unit was designed to travel at a top speed of 25 m.p.h. when pulling a 65,000 lb towed load. The drive mechanism is of four-wheel design, with the front and rear wheels on each side geared together. Manœuvrability has been obtained with the aid of four-wheel hydraulic power steering, which permits the control of both sets of front and rear wheels simultaneously or independently. Thus, all four wheels could be turned simultaneously to the same angle if desired and the unit would then move sideways at that angle. The tractor can also be steered by means of braking. Motive power is provided by a 300 h.p. diesel engine driving through a torque converter and a semi-automatic gear transmission.

Tractor - Bulldozer

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.

STEEL BUTT WELDING PIPE FITTINGS FOR THE PETROLEUM INDUSTRY

No. 1640 : 1953. Price 7s. 6d. The 1950 edition of this Standard has been revised in the light of experience in its use and opportunity has been taken to bring certain dimensions into line with those in the latest edition of American Standards Association Specification B.16.9, "Steel Butt Welding Fittings."

The Standard specifies requirements for seamless and fabricated carbon and alloy steel 45 deg. elbows, 90 deg. elbows (long and short radius), return bends (long and short radius), 90 deg. tangent elbows, equal tees, reducing tees, concentric and eccentric reducers, caps and lap-joint stub ends.

SINGLE-PHASE, TWO-WIRE PREPAYMENT METERS

No. 37, Part 3 : 1953. Parts 1 and 2, 4s. ; Part 3, 4s. This part deals with single-rate (flat rate) multi-rate (load rate) and two-part tariff prepayment meters for systems not exceeding 250V. Such types of meter combine a single-phase, two-wire element with a coin-freed mechanism wholly or partially controlled by the meter. The standard ratings are 10A, and 40A, corresponding to the maximum continuous rated current. Details are specified for the coin-register and the credit and debit indicators as well as the normal electrical requirements. Certain features recommended for incorporation in future designs of meter are included in the appendices. Part 1, "General Clauses Applicable to All Types of Motor Meter," and Part 2, "Single-phase, Two-wire Whole Current Credit Type Meters," were published together as a single document some months ago.

INDUSTRY IN THE COMMONWEALTH.—The Industrial Welfare Society says that, with the approval of its Patron, H.R.H. The Duke of Edinburgh, a conference for young men and women from this country and the Commonwealth is to be held in London in about eighteen months' time. This conference will be known as The Duke of Edinburgh's conference on "The Responsibility of Industry in the Commonwealth." The delegates to the conference will be selected from young men and women holding, or destined to hold, positions of responsibility in industry and commerce. The conference will last about ten days.

Industrial and Labour Notes

Overseas Trade

The Board of Trade has estimated provisionally that exports of United Kingdom goods in August were valued at £198,100,000. There were only twenty-five working days in August, and the whole of the month was, of course, affected by holidays in industry. In making comparison with earlier periods, therefore, the Board of Trade has examined the two months, July and August, together.

The average monthly value of exports in that period was £216,300,000, compared with a monthly average of £210 million in the second quarter of this year and £208,500,000 in the first quarter. The average value of imports in July and August at £271,100,000 was 7 per cent below the level of the second quarter and was slightly below the first quarter's monthly average. Re-exports in August have been valued provisionally at £8,800,000, and the excess of total imports over total exports was therefore £42,300,000. Taking July and August together, the excess averaged £46,200,000, which, the Board of Trade says, was well below the monthly average of either of the two preceding quarters.

The Trades Union Congress

On Wednesday of last week, the Trades Union Congress, which was in session at Douglas, Isle of Man, discussed the special report on public ownership which has been prepared by the general council. The report was presented, on behalf of the general council, by Mr. C. J. Geddes.

The main conclusions set out in the report are that it is, for the most part, impossible at the present stage to say which industries should become publicly owned, as that is a matter which can only be decided after further thorough investigation of the facts and in the light of the country's changing economic fortunes. In moving the adoption of the report, Mr. Geddes said it was essential to the success of extended social ownership that men and women in industry should understand precisely what it meant, that it was not merely a doctrine but that it was a policy directed primarily to the economic solution of problems facing the nation. A motion for the "reference back" of the report failed to gain the support of the Congress and the report was therefore accepted.

On Thursday of last week, one of the debates was concerned with wages policy. A resolution was carried opposing any kind of wage restraint which would interfere with the freedom of collective bargaining and independent arbitration. The resolution called upon the general council to make a vigorous effort to compel the Government to stabilise the cost of living. Another resolution asked the Congress to reject wage restraint completely and to support the activities of unions which were campaigning in favour of higher wages. This resolution was moved by Mr. W. Stevens, the general secretary of the Electrical Trades Union, who claimed that wages could still come from profits and need not lead to increased prices. Mr. Arthur Deakin, on behalf of the general council, commented that if the Congress accepted the suggestion it would negative the preceding resolution. He described the resolution as an invitation to set out on "a disastrous adventure based on the economics of Bedlam." The resolution was defeated.

The Electrical Contracting Industry Dispute

The strikes in the electrical contracting industry in various parts of the country continued throughout last week, and by last Friday it was reported that over 4000 men had ceased work. These strikes, which were organised by the Electrical Trades Union, started over a wage dispute between the union and the National Federated Electrical Association. At a recent meeting, the National Joint Industrial Council for the industry failed to reach agreement as the union representatives were not willing to accept the employers' association's request to consult its member firms.

During last week conciliation officers of the Ministry of Labour had further lengthy conversations with union officials and with the employers' representatives, and on Thursday of last week it was stated that the Minister of Labour had decided to set up a court of inquiry to examine the causes and circumstances of the dispute. Mr. John Cameron, Q.C., has agreed to preside over the court, the other members being Sir Graham Cunningham, chairman of the Triplex Safety Glass Company, Ltd., and Mr. G. B. Thorneycroft, who was until recently the general secretary of the Transport Salaried Staffs Association. The first meeting of the court was held yesterday.

Following the Ministry of Labour's announcement about the setting up of the court of inquiry, the National Federated Electrical Association stated that it would comply with the Minister's request to withhold any action arranged or contemplated until after the court had investigated the dispute. On Monday of this week, the general secretary of the Electrical Trades Union said that meetings of the strikers in all the areas affected would be arranged. The men would be "strongly recommended" to resume work.

Industrial Relations

A conference on "Advanced Management," which has been arranged by the Organisation for European Economic Co-operation, was opened at Henley-on-Thames last Monday by the Parliamentary Secretary to the Ministry of Labour, Mr. Harold Watkinson. In the course of his speech, Mr. Watkinson said that management to-day had an inescapable responsibility to explain in simple terms to its workpeople a great many things about its business. It was not always easy to explain simply how the trading position of a company was related to the everyday lives of its employees, but it must be realised that such matters would be discussed by the workers in any case. It was better, Mr. Watkinson observed, that they should be discussed against a background of factual knowledge rather than against one of misrepresentation and rumour provided by the agitator.

Mr. Watkinson went on to say that, although there was now consultation at the top between the Government and the National Joint Advisory Council and similar bodies, the Government was not yet convinced that that had really solved the problem. Until there really was a two-way traffic of ideas between management and the floor of the shop, it could not be considered that the most difficult and fundamental problem of higher management had been solved. That consultation, Mr. Watkinson added, must be encouraged as much by the trade unions as by employers, but the responsibility of initiating the two-way traffic rested with management. Despite the progress which had been made in increasing productivity, it was probable that this country had not yet reached the half-way mark towards the goal of the highest levels of efficiency and output. Progress, Mr. Watkinson said, would not be sufficient to satisfy national needs unless the science and practice of management made as great an advance as had the tools and technologies provided for its use.

The Schuman Community

In the August number of its *Monthly Statistical Bulletin*, the British Iron and Steel Federation has surveyed the first year's activities of the European Coal and Steel Community. It will be recalled that, shortly after the Community came into being on August 10, 1952, the United Kingdom Government appointed a delegation to the high authority, and a joint committee representing both parties has met to study the conditions necessary to the establishment of the intimate and lasting association between this country and the Community, which is the objective of the United Kingdom Government. Recently, the high authority has announced that, in the coming months, it will put forward proposals for such an association.

In concluding its survey, the British Iron and Steel Federation says that, though membership of the Community is open to all European countries, it is with the United Kingdom that the Community is most anxious, on both economic and political grounds, to establish a permanent association. At the first meeting, last November, of the joint committee representing the United Kingdom and the high authority, Monsieur Monnet indicated that what he had in mind was not a commercial agreement or a division of overseas markets but common action, common responsibilities and rights and obligations shared on a basis of equality. He then put forward the following points as a basis for discussion :— The organisation of a mutual exchange of information on the forecasts and objectives of each in regard to investments, production, supplies and markets ; the establishment of permanent facilities for consultation on questions which either associated party wishes to raise with the other; the application in specific fields of rules to be defined by common agreement and by which both parties shall abide, and the creation of an international framework permanently assuring concerted action between Great Britain and the European Coal and Steel Community which the high authority wishes to make as comprehensive as possible.

The Federation says that now the machinery of the common market for coal and steel is actually in operation, the high authority is in a better position to put forward concrete proposals for association with the United Kingdom. It adds the comment that, since no other basis has been suggested, it may be presumed that the proposals which may be expected shortly will follow the general lines indicated by Monsieur Monnet last year.

The Price of Materials

The Board of Trade has stated that the level of the basic materials index (June 30, 1949=100) was 142·8 in August, and was the lowest recorded for three years. The fall from the July level of 143·7 was brought about mainly by a decline of approximately 8 per cent in the price of copper. There were not many other price changes during August, rises in the prices of a few items such as lead, which was up by 1·7 per cent, shellac up by 10·8 per cent, and pure benzol up by 2·4 per cent, being accompanied and largely offset by falls in the prices of tin, which was down 3·2 per cent, hides and skins down 1·2 per cent, imported softwood down 0·6 per cent, and raw rubber, the price of which fell 1·8 per cent.

Figures published by the Board of Trade show that the price indices for materials used in the mechanical engineering and the electrical machinery industries both fell during August, the former by 0·9 per cent and the latter by 2 per cent. In both cases, rises in the prices of paint (up by only 0·1 per cent) and of lead were substantially offset by falls in the prices of copper and brass and tin items, as well as in the price of rubber. The much heavier weight carried by copper items in the electrical machinery materials index accounted for its greater decline. There was also little change in August in the indices for building materials. A rise of 0·1 per cent in the index for house building materials was caused mainly by an increase of about 1 per cent in the price of various building bricks, which increase was largely offset by a fall in the prices of imported softwood, joinery and various wire and copper items. The building and civil engineering materials index, in which bricks have a smaller weight, fell by 0·1 per cent during August.

Notes and Memoranda

Rail and Road

LOCOMOTIVE MAINTENANCE.—The Railway Executive says that British Railways steam locomotives are running more trouble-free miles than ever before. The latest statistics available, for the four weeks to June 13th, show that the average mileage run between mechanical failures was 32,878 as compared with 19,174 for the corresponding period in 1949 ; 20,365 in 1950 ; 26,319 in 1951, and 32,183 in 1952. This improvement, it is claimed, is due to the introduction of the standard examination system throughout British Railways, which provides for better maintenance.

LIGHTWEIGHT DIESEL TRAINS ON BRITISH RAILWAYS.—Local steam trains in the West Cumberland district of British Railways (London Midland Region) are to be replaced by diesel coach trains. This is the second area to be selected in giving effect to the policy, announced last November, to employ diesel units wherever suitable to reinforce or replace steam services ; the first area to be selected was the West Riding of Yorkshire. The West Cumberland scheme, which it is expected will come into operation in the autumn of 1954, will cost over £330,000, and provides for the diesel units to work local services on 120 miles of route.

Air and Water

TEES DRAINAGE SCHEME.—According to the *Tees-side Journal of Commerce*, a drainage scheme costing £5850 is to be carried out on part of the River Tees to alleviate flooding in the Bishopton and Billingham districts. It is stated that the work will involve the removal of shoals and the deepening of the river.

UNION CASTLE LINE COMMODORE.—Captain T. W. McAllen, who has completed fifty-three years at sea and who was promoted commodore of the Union Castle fleet in 1950, will retire from that position when he returns to England in the "Edinburgh Castle" in December. He will be succeeded by Captain G. H. Mayhew, who joined the company in 1921 and is at present in command of the "Pretoria Castle."

INSTITUTE OF MARINE ENGINEERS.—The next examinations for admission to the Institute of Marine Engineers are to be held as follows :—Students (common preliminary examination), April 6 to 9 and October 5 to 8, 1954 ; Graduates (Sections A and B of Associate Membership Examination), April 26 to May 19, 1954 ; Associate Members, April 26 to May 20, 1954. Syllabuses of these examinations and particulars of exempting qualifications can be obtained from the Secretary of the Institute of Marine Engineers, 85, Minories, London, E.C.3.

COMMUNICATIONS IN SIERRA LEONE.—A new deep-water quay is nearing completion in Sierra Leone, and its construction, it is stated, emphasises the great need for improved communications throughout the Protectorate generally. The six major rivers which flow diagonally across Sierra Leone present some obstacles to road communications, and until recently there were only short roads feeding the railway. Now, however, a co-ordinated system of road, rail and water transport is being planned. The programme includes the provision of bridges, carrying a single line of traffic, to replace ferry crossings over several rivers, and the construction of three roads totalling 116 miles. The first of these roads will be about 40 miles long and will link the extreme north of the Protectorate with the inland port of Kambia, and the second road will be built between Bandajuma and Potori. The third road, about 50 miles long, will run from Kwelu to Victoria via Kangahun, and will open up large tracts of country.

Miscellanea

MR. FELIX HARMER.—We have learned with regret of the death of Mr. Felix Harmer, which occurred after a prolonged illness on September 10th. Mr. Harmer served his apprenticeship with Alfred Herbert, Ltd., Coventry, and was subsequently appointed the firm's chief representative for equipment for the production of dies and moulds.

FUEL EFFICIENCY EXHIBITION.—A Fuel Efficiency Exhibition is to be held in the City Hall, Deansgate, Manchester, from Wednesday to Saturday, November 18th to 28th. The early part of the exhibition will coincide with a conference organised by the Combustion Engineering Association, which will take place at the Grand Hotel, Manchester, on November 18th, 19th and 20th.

A SIMPLE COMPUTER FOR THE MANIPULATION OF COMPLEX NUMBERS.—A simple computer designed primarily to simplify electrical network calculations is described in a paper by Mr. R. B. Robinson in *The Journal of the Institution of Engineers, Australia*, June, 1953. The computer consists, essentially, of five circular slides marked or engraved with the appropriate scales or curves for calculations involving complex numbers.

"FESCO FOUNDRY DEVELOPMENTS."—The first edition has just been published of *Fesco Foundry Developments*, a new house magazine of Foundry Services, Ltd., Long Acre, Nechells, Birmingham, 7. In this edition there are described five recent investigations carried out in the firm's laboratories : "The Development of Kalmin Sleeves," "The Degassing Efficiency of Hexachloroethane and Nitrogen," "A Miniature Experimental Cupola," "A Routine Test for Fluxes," and "The Reduction of Melting Losses on Copper Base Alloys."

CENSUS OF PRODUCTION, 1950.—Volume 12 of the report on the census of production for 1950 has now been published by H.M. Stationery Office, York House, Kingsway, London, W.C.2, price 1s. 6d. It is entitled *Building and Contracting, Gas, Electricity and Water*, and covers building and contracting ; local authorities (building and civil engineering) ; railways (civil engineering) ; tramway, trolley bus and omnibus undertakings (civil engineering) ; canal, dock and harbour undertakings (civil engineering) ; gas supply industry ; electricity supply industry, and water undertakings.

I.MECH.E. GROUP DISCUSSIONS.—The council of the Institution of Mechanical Engineers states that a series of "group discussions" is being arranged. These meetings, which are to be held in association with the Institution's specialist groups, will generally take place on Wednesday evenings, beginning at 6.45 p.m. No formal paper will be presented and no record of the proceedings will be taken. The subject at each meeting will be briefly introduced by a knowledgeble member and will then be open to general discussion. Subjects will be chosen by the group committees for their general interest and topicality.

BRITISH IRON AND STEEL FEDERATION.—The British Iron and Steel Federation has announced the appointment of Mr. Frederick Grant, Q.C., as the independent chairman of its executive committee. In this appointment, Mr. Grant succeeds the late Sir Andrew Duncan, since whose death in March, 1952, the office has been vacant. It has been suggested that the principal matters with which the new chairman will be immediately concerned are the second development plan which has been approved for the steel industry, steel prices, and the relationship of the British steel industry with the Schuman community.

COPPER AND COPPER ALLOYS.—Complete cancellation of the common list of end-use prohibitions for copper and copper alloys, agreed upon by member-countries in September, 1951, has been decided upon by the Council of the Organisation for European Economic Co-operation. The decision took effect on September 4th. This common list was suspended in December, 1952, owing to the improved position of copper supplies, but the organisation's non-ferrous metals committee was instructed to keep a close watch on the situation in case the re-imposition of restrictions became necessary. The committee has now reported that the maintenance in abeyance of a common list of prohibitions serves no useful purpose, since the present satisfactory situation of world supplies has enabled all member countries to remove their national end-use restrictions.

OBITUARY.—We record with regret the death of Lord Westwood of Gosforth, which occurred at his home at Newcastle upon Tyne, on September 13th. Lord Westwood, who was seventy-three, had had a long and active association with the engineering and shipbuilding industries. He was for many years president of the Confederation of Shipbuilding and Engineering Unions, and at the time of his death was president of the Institution of Engineering Draughtsmen and Designers. In the early years of the second world war, Lord Westwood served as labour and industrial adviser to the Admiralty. . . . We regret to record also the death, on August 26th, after a short illness, of Mr. Francis Patrick Irwin Crossley, a director of Crossley Brothers, Ltd., and Crossley-Premier Engines, Ltd. Mr. Crossley was the grandson of Sir Kenneth Crossley, the chairman of the companies.

DUAL-PURPOSE TRACTOR.—At the British Electricity Authority's Ferrybridge Power Station, near Leeds, an additional use has been found for a "Challenger 3" heavy crawler tractor. The bulldozer blade has been removed from the tractor and a cast iron roller, weighing 2 tons and constructed at the station, has been fitted to the bulldozer mounting frame. With this arrangement the tractor is used to compact a hard level surface on the stack of small coal at the station to prevent air from entering and causing spontaneous combustion. The stack covers about 33,000 square yards. Compacting also provides a temporary road, enabling coal wagons of 6 tons to 8 tons capacity to travel easily across the hardened surface of the stack. Additional weight can be imparted to the rolling operation by setting the unit in the normal "dig" position. The "Challenger 3," it will be recalled, is a 95 h.p. diesel crawler tractor made by John Fowler and Co. (Leeds), Ltd.

A MOBILE TIPPLER FOR MINES.—Particulars have been received from the National Coal Board of a mobile tippler which has been devised to speed dirt disposal at Comrie Colliery, Fife. Based on conventional tippler design, this machine can be moved to various points on the colliery tip along the tracks used for carrying the mine cars. When tipping is in progress the mine cars run up long shallow ramps on each rail on to the tipping stage. Ropes connected to two corners of the stage lead up over pulleys in the top of the frame and down to the driving shaft. This shaft is rotated to tip the stage by a 25 h.p. electric motor. An electrical cut-out switch on one of the catch hooks at the top of the frame stops the motor and applies the brake when the leading edge of the stage reaches the tipping angle of 45 deg. When the tippler has to be moved to a new site on the tip it is drawn by the diesel locomotive which hauls the cars. It is stated that the installation of this machine has enabled the number of men on disposal work to be reduced. Previously, eighteen manshifts were needed to empty 92 mine cars in twenty-four hours, now seven manshifts do the same work. The tippler was designed and developed by Mr. William Crane, chief engineer of Comrie Colliery.

CHADWICK PUBLIC LECTURES.—The forty-first annual series of public lectures arranged by the Chadwick Trust will begin on Thursday, October 15th. At 5.30 p.m. on that day, at the Royal Society of Arts, John Adam Street, Adelphi, W.C.2, a lecture entitled "Air Pollution," will be delivered by Mr. C. J. Regan, chemist-in-chief of the London County Council. Subsequent lectures in the series will be given on Tuesday, November 17th, on "The Public Health Significance of Environmental Control by Engineering Means," the lecturer being Dr. John A. Logan, and on Thursday, December 3rd, when Professor B. W. Windeyer will deliver the Malcolm Morris Memorial Lecture entitled "Radio-Therapy in its Relation to Dermatology."

REFRESHER COURSE FOR WORKS ENGINEERS.—The Institution of Incorporated Plant Engineers states that its education committee has arranged a comprehensive refresher course for works and plant engineers in the West Riding, comprising twenty weekly lectures to be given at Leeds University on Thursday evenings, commencing on October 15th. The course is designed to encourage the most effective use of existing knowledge and to promote the application of up-to-date techniques in works engineering practice over a wide field. It will cover many subjects of everyday importance to works and plant engineers, and particular regard is to be paid to the requirements of the area. The fee for the course is Three Guineas and copies of the syllabus and full particulars may be obtained from the Secretary to the Refresher Course, The Department of Engineering, The University, Leeds, 2.

Personal and Business

MACHINERY INSTALLATIONS states that its address is now 14, Grey Street, Newcastle upon Tyne.

MR. J. H. GROVES has been appointed sales manager of the Power Plant Company, Ltd., West Drayton, Middlesex.

MR. ROLT HAMMOND, A.C.G.I., 54, New Street, Henley-on-Thames, informs us that he has resigned the editorship of *Machinery Lloyd*.

MR. A. LOCKWOOD is retiring at the end of this month from the chairmanship of the Southern Electricity Consultative Council.

MR. T. J. LEE has succeeded the late Mr. F. L. Tingle as managing director of the Tenuous Steel Company, Ltd., Wentworth Street, Sheffield, 6.

W. H. HEYWOOD AND CO., Ltd., Huddersfield, states that its London office is now at Hope House, Great Peter Street, Westminster, S.W.1 (telephone, Abbey 1077).

TUBE INVESTMENTS, Ltd., announces that agreement has been reached, subject to the completion of formalities, for the acquisition of W. H. A. Robertson and Co., Ltd., Bedford.

THE HYSTER COMPANY OF HOLLAND states that its new plant at Nijmegen, for the production of materials handling equipment and crawler tractor attachments, is to be opened on October 3rd.

F. J. EDWARDS, Ltd., 359–361, Euston Road, London, N.W.1, states that it has made an arrangement with Trumpf and Co., Stuttgart, to act as sole agent in the United Kingdom for the latter company's shearing and nibbling machines.

MR. G. PICKERING has been appointed principal surveyor to Lloyd's Register of Shipping at Liverpool, in succession to the late Mr. T. Pratt. Since 1948, Mr. Pickering has been Lloyd's senior engineer surveyor at the port of Liverpool.

MR. K. P. WOOD, M.A., who recently resigned from the board of James Beresford and Son, Ltd., has now started his own business at 71, Temple Row, Birmingham, 2. His activities include representation in the Midlands of Edward Holme and Co. (1931), Ltd., and the K.S.B. Manufacturing Company, Ltd.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park, Manchester, announces the following appointments :—Mr. T. R. Porter, superintendent, control department ; Mr. E. T. W. Barnes, superintendent, radio department, and Mr. A. J. R. Veale, assistant superintendent, radio department.

THE SELSON MACHINE TOOL COMPANY, Ltd., North Acton, London, W.3, has been appointed sole agent in the United Kingdom to the following Continental machine tool manufacturing firms :—Richard Stuhlmann and Co., Alfred Gauthier G.m.b.H., Prahoma-Werk Kehren and Co., Etablissements M. de Valliere, and Ateliers Peeters.

MR. A. S. HEGGIE, formerly of Kenneth Hudson and Son, has joined the Owen Organisation's export department at Kent House, Market Place, Oxford Circus, London, W.1. Mr. Heggie is concerned with the export sales of the agricultural machinery products of Kenneth Hudson and Son, Salopian Engineers, Ltd., and Rubery, Owen and Co., Ltd.

THE SOCIETY OF MOTOR MANUFACTURERS AND TRADERS states that Mr. B. G. J. Clarke has been appointed to succeed Mr. A. W. Hamilton Brown as its representative in New Zealand and the Far East. Mr. Hamilton Brown has relinquished his position with the S.M.M.T. to become managing director of the Standard Motor Company in New Zealand.

PILGRIM MOBILE UNITS, Ltd., is the name of a new company formed to handle mobile trailer units for use by industry in this country and overseas. Major J. V. Phipps is the chairman of the company, and Mr. D. R. Hobson, managing director. The company's head offices and works are at Ringwood, Hants (telephone, Ringwood 381), and there is a London office at 176, Piccadilly, W.1 (telephone, Hyde Park 0479).

British Patent Specifications

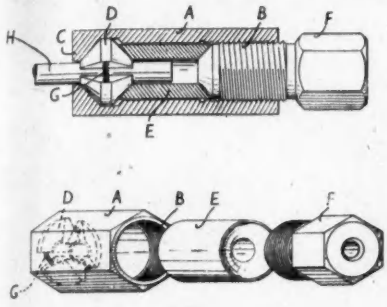
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 1d. each.

WORKSHOP TOOLS AND APPLIANCES

695,021. May 2, 1950.—A GRIPPING TOOL, William Jones, 57, Tideswell Road, Eastbourne; and John William Green, 12, Lottbridge Down, Hampden Park, Eastbourne.

The tool shown comprises a hexagonal tubular body *A* internally formed at one end with a thread *B* and at the other end with an inwardly directed flange *C* which presents a conical surface to the jaws *D*. These jaws are formed with a part cylindrical central portion and part conical end portions, which abut against the conical surface on the flange *C* and the conical surface on one end of a sleeve *E*. This sleeve, which can slide in the bore of the body, is held in contact with the jaws *D* by a tubular bolt *F*. By screwing the bolt into and out of the holder the jaws, which are held apart from one another by the springs *G*, may be closed or opened.

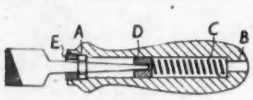


No. 695,021

In order to use the tool to grip a stud or spindle *H* the adjusting bolt *F* is screwed into the holder so that the sleeve *E* is forced against the jaws *D* to force these in turn along the internal coned portion of the body until the internal ribbing of the jaws bites on to the spindle to be gripped. It will be found that when assembled and used there is no tendency of the jaws to catch on the inner surface of the body when the adjusting member is turned. In some circumstances the jaws may be screw threaded or formed with circular, instead of longitudinal, splines, to give the required grip on the member to be extracted.—*August* 5, 1953.

695,123. May 23, 1950.—HANDLES FOR HAND TOOLS, John James Carr, 12, Plum Lane, Plumstead, London, S.E.18.

The invention relates to handles for hand tools having a tapered tang, such as files, scrapers and chisels. The file handle shown is an aluminium alloy casting having a hole through its centre. The hole is enlarged at the left-hand end to form a hexagonal recess *A*, and a rib *B* is formed at the right-hand end of the hole. A coil spring *C* inserted in the hole abuts against the rib *B*. A cylindrical abutment member *D* contacts the other end of the spring, and can slide in the hole. The abutment member has a central passage for locating the pointed end of a tang of a file. A case-hardened standard Whitworth



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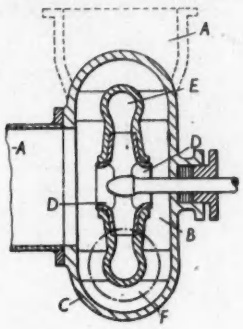
nut located in the hexagonal recess is secured in position by a collar *E* screwed into the recess to grip the nut between the shoulder and the collar. The file is secured to the handle in the following manner. The tang is inserted through the collar and the nut and the pointed end of the tang enters the passage in the abutment member. The tang eventually jambs in the member and pushes it towards the right-hand end of the handle against the spring. Further insertion of the tang eventually causes it to jamb in the nut. The file is then screwed into the handle and the case-hardened nut cuts a thread on the relatively soft tang. The inter-engagement of the nut and the screw thread cut on the tang causes the file to be firmly secured within the handle. The abutment member serves to guide the tang whilst being inserted in the hole and aids in supporting the file when properly inserted in the handle, so that undue strain is not placed on the nut during working. The case-hardened nut acts as a screw cutting die.—*August* 5, 1953.

PUMPS

695,367. April 28, 1950.—CENTRIFUGAL PUMPS, Henschel and Sohn G.m.b.H., 2, Henschelstrasse, Kassel, Germany. (*Inventor: Harald Hany.*)

The invention aims at obviating ebullition by providing a pump suitable for delivering hot liquids



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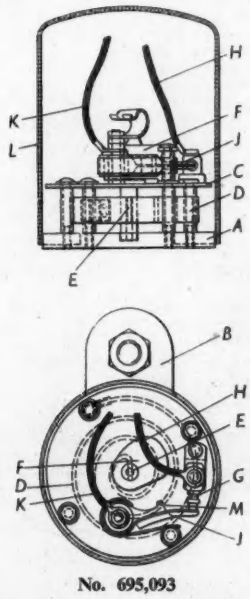
even with a low inlet head without the necessity of using an auxiliary supply pump. It prevents evaporation or accumulation of gas bubbles in the core of the influx and pre-rotation of the inflowing liquid near the pump wheel inlet which would cause the effective inlet area to be reduced in consequence of the formation of a rotary whirl. As shown in the drawing, the supply pipe *A* is arranged in an axial direction and an annular space *B* is formed by a jacket *C* surrounding the casing. The small diameters of the inlets and the large area of the supply pipe *A*, as well as the insertion of the complete pump casing *E* inside the space *B*, which is full of liquid, are seen in the drawing, which shows the effects and advantages of the design. This design may be modified by having a radially arranged, large diameter supply pipe *A* as shown in dotted lines, instead of the axial pipe shown. *F* is the delivery pipe connection. The specification also shows a pump inserted completely in the liquid contents of a tank. Any gas bubbles formed are pushed away from the inlets and will rise to the surface, and the formation of a cavity near the pump wheel inlet is prevented.—*August* 12, 1953.

INTERNAL COMBUSTION ENGINES

695,093. May 8, 1952.—APPARATUS FOR PREVENTING OVER-HEATING OF INTERNAL COMBUSTION ENGINES, Gustav Folke Nilsson, Kullen, 15, Avesta, Sweden.

Referring to the drawing, it will be seen that a plate base *A* of material possessing good heat-conducting properties, such as aluminium, is provided with a lug *B* for securing to the cylinder head



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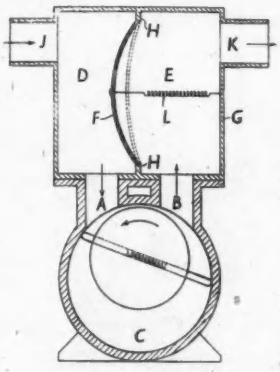
by means of one of the cylinder head bolts. Secured above and in spaced relation to the plate *A* by means of bolts is a disc *C* and between the base and the disc is a spiral bimetallic spring *D* of flat section. The outer end of the spring is attached to one of the bolts connecting the plate and the disc, and the inner end of the spring is attached to the lower end of a central spindle *E* extending through an aperture in the disc *C* and having a cam *F* secured to the upper end above the disc. Attached to the upper side of the disc through an adjustable insulated bridge is a switch having a contact *G* which is connected by a lead *H* to one terminal in an ignition circuit of an engine, a movable spring-actuated and insulated contact arm *J* also secured to the disc is electrically connected to another terminal of the circuit by means of a lead *K*. The whole apparatus is enclosed within a cap *L*. When the engine becomes over-heated in operation, the bimetallic spring *D* is caused to contract and the metal having the greater coefficient of thermal expansion being located outermost, the bimetallic spring turns the spindle *E* with the cam *F* towards the contact arm *J*. When the cam is brought into contact with an insulated abutment *M* of the contact arm *J*, the contact between the arm and the contact *G* is opened so that the ignition current is interrupted and the engine is brought to a standstill. By adjustment of the contact *G* the interruption of the ignition current may be controlled so as to take place at 90 deg. to 95 deg. Cent., at which temperature no risk of the engine becoming over-heated is incurred. As soon as the temperature of the engine is reduced below the adjusted value, the circuit of the ignition current will again be closed. In a similar way an additional switch may be provided with a contact which, on the turning movement of the spindle *E* with the cam *F*, is closed so as to light a signal lamp when the engine is at a temperature most suitable for its operation, or when the temperature falls below a predetermined value.—*August* 5, 1953.

MISCELLANEOUS

695,556. March 3, 1950.—REDUCTION OF PULSATIONS PRODUCED IN FLUIDS BY THE OPERATION OF PUMPS, BLOWERS, FANS, INTERNAL COMBUSTION ENGINES, Metropolitan-Vickers Electrical Company, Ltd., St. Paul's Corner, 1–3, St. Paul's Churchyard, London, E.C.4. (*Inventor: Arthur Samuel Ennis.*)

As shown in the drawing, the air streams at the inlet and outlet ports *A* and *B* of the blower *C* are arranged to pass through inlet and outlet chambers *D* and *E*, which are separated by a flexible diaphragm *F*, the two chambers being formed by a cubical container *G* which is divided into two equal parts by a barrier *H* formed with an aperture which is covered by a sheet of material forming the diaphragm. Alternatively, the barrier *H* may be formed with more than



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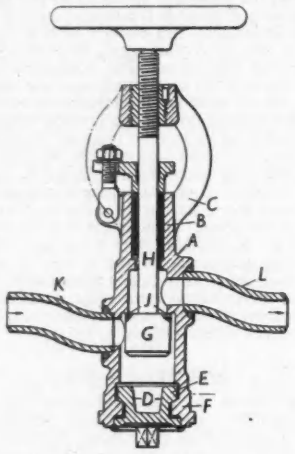
one aperture each covered with material forming a diaphragm. The container *G* is mounted on the blower *C* so that the inlet port *A* communicates with the inlet chamber *D* and the outlet port *B* with the outlet chamber *E*, air being admitted by a port *J* near the top of the inlet chamber *D* and exhausted after passing through the blower *C* from a port *K* near the top of the outlet chamber *E*. The blower in drawing air in, deflects the diaphragm *F* due to the reduction of pressure in the inlet chamber *D*, and the corresponding reduction in volume provides some of the air for the intake pulse. In making this movement the diaphragm *F* increases the volume of the outlet chamber *E* to accommodate the outlet pulse, and is assisted in its movements by the increase in pressure which takes place at the outlet port. Following this movement and when the air movement through the blower is at a minimum, the diaphragm will return to a mean position ready for the next sequence. Accordingly, the oscillating or alternating component of the air stream is circulated in effect round the blower through the flexible diaphragm, while the steady component is passed through. Pressure on the diaphragm due to this steady component is balanced by a resilient tie *L* between the centre of the diaphragm *F* and the wall of the chamber

E. The arrangement described will function efficiently only if the inlet and the outlet pulses are, or can be made to be, approximately equal in magnitude and opposite in phase at the diaphragm. For the best results the diaphragm should be fitted as near to the blower as is practicable. The specification also describes the application of the invention to fans, pumps and internal combustion engines.—*August* 12, 1953.

VALVES

695,847. November 2, 1951.—STOP VALVES, Dewrance and Co., Ltd., Great Dover Street, London, S.E.1.

As shown in the drawing, the valve body comprises a barrel part *A* including a stuffing-box *B* and a yoke *C* formed in one piece. The lower end of the barrel



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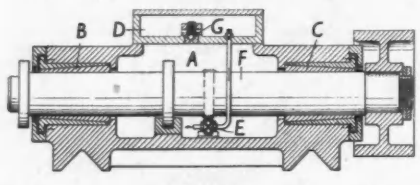
A is closed by a stopper *D* held in place by a bayonet coupling. The stopper is provided with diametrically opposite radially outwardly extending lugs *E*, which engage behind corresponding lugs *F* on the barrel. The diameter of the barrel between the lugs is sufficient to permit the passage of a valve disc *G* on a valve spindle *H* and engaging a seating *J* on the barrel. Extending through bosses on the outside of the barrel and communicating with the interior of the body, below and above the valve seating *J*, are openings from which extend welded connecting pipes *K* and *L*, provided at their free ends with bevelled welding edges. The gland and spindle operating gear are of normal construction. A modified design is also described in the specification.—*August* 19, 1953.

MACHINE TOOLS

695,973. October 9, 1950.—LUBRICATION OF GRINDING MACHINE SPINDLES, The Churchill Machine Tool Company, Ltd., Atlantic Street, Broadheath, Near Manchester, and George Herbert Asbridge, of the company's address.



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As the drawing shows, the housing *A*, which has the spindle bearings *B* and *C* at its opposite ends, is below an oil reservoir *D*. A pump *E* driven by the wheel spindle *F* and immersed in the oil draws oil from the reservoir *D* and delivers it into the housing so as to keep it full and prevent the presence of any air. A relief valve *G* on the top of the housing allows oil to flow to the reservoir above. This valve may be a spring loaded ball valve and it maintains any desired oil pressure in the housing. Such pressure may, however, be only that necessary to cause flow from the housing to the reservoir to relieve the flow into the housing due to the pump. By the invention constant lubrication conditions in the bearings of the grinding wheel spindle are obtained. —*August* 19, 1953.

SAFETY IN FORK LIFT TRUCK OPERATION.—An interesting little leaflet has been published by I.T.D., Ltd., 95/99, Ladbroke Grove, London, W.11, for issue to customers using its fork lift trucks. This leaflet illustrates and describes graphically the safety precautions which should be observed by fork lift truck operators. Thirty rules for safe working are listed and sixteen small cartoons are used to illustrate the possible results of not taking elementary precautions.

Contracts

CONTRACTS have been placed by the British Electricity Authority during the past month for power stations, transforming stations and transmission lines amounting in the aggregate to £7,063,046. The principal contracts include: Brighton "B" power station, piling for foundations for two turbo-generator sets (Holloway Brothers (London), Ltd.); Cowes power station, superstructure (John Croad, Ltd.); South Denes power station, Yarmouth, two 550,000 lb per hour boilers (International Combustion, Ltd.), two 60MW turbo-generators and auxiliary apparatus (Metropolitan-Vickers Electrical Company, Ltd.), and condensing and feed heating plants for two 60MW turbo-generators (Vickers-Armstrongs, Ltd.); Castle Donington power station, near Derby, main building superstructure (Taylor Woodrow Construction, Ltd.); Northampton power station, steel framework to boiler-house and turbine house (Dorman Long and Co., Ltd.); Nottingham power station, foundations and culverts (Taylor Woodrow Construction, Ltd.), and one 72MVA transformer and one 6MVA transformer (Metropolitan-Vickers Electrical Company, Ltd.); Hams Hall "C" power station, near Birmingham, 3·3kV auxiliary switchgear (A. Reyrolle and Co., Ltd.); Meaford "B" power station, Stone, Staffs, one 515,000 lb per hour boiler (Babcock and Wilcox, Ltd.); Uskmouth power station, Newport, condensing and feed heating plant for one turbo-generator set (Vickers-Armstrongs, Ltd.); Doncaster power station, second section of superstructure (J. Gerrard and Sons, Ltd.); Ferrybridge "B" power station, Yorks, generator transformer (C. A. Parsons and Co., Ltd.), and two 10MVA transformers (Fuller Electrical and Manufacturing Company, Ltd.); Barony power station, Ayr, structural steelwork for main building and annexes (Colville Constructional Company, Ltd.); Andover substation, Hants, 132kV, 2500MVA switchgear (British Thomson-Houston Company, Ltd.); Elstree substation, site and foundation works (J. L. Eve Construction Company, Ltd.); Staythorpe substation, Newark, site and foundation works (M. J. Gleeson (Contractors), Ltd.); Pyle substation, Glam, 132kV switchgear (English Electric Company, Ltd.); Creyke Beck substation, Yorks, 132kV, 2500MVA switchgear (A. Reyrolle and Co., Ltd.), and Ferrybridge "B" substation, Yorks, site and foundation works (M. Harrison and Co. (Leeds), Ltd.).

Launches and Trial Trips

FORT CARILLON, banana carrier; built by the Ateliers et Chantiers de Bretagne for the Cie. Gale Transatlantique; length between perpendiculars 344ft 6in, breadth moulded 51ft 6½in, depth moulded to main deck 28ft 3in, load draught 21ft 4in, displacement 5900 tons, deadweight (banana) 1100 tons; four air refrigerated holds and corresponding 'tween decks, isothermic watertight MacGregor hatch covers, three Brissonnean and Lodz compressors; Burmeister and Wain two-stroke, single-acting diesel engine, ten cylinders, 5250 b.h.p. at 131 r.p.m.; three 230kW diesel-driven generators, service speed 15·5 knots. Trial, August.

BURMAH SAPPHIRE, oil tanker; built by Swan, Hunter and Wigham Richardson, Ltd., for the Burmah Oil Company (Tankers), Ltd.; length between perpendiculars 407ft 6in, breadth moulded 56ft, depth moulded 31ft 3in, load draught 25ft 2½in, deadweight 8460 tons, service speed 12 knots; twenty-four cargo oil tanks, two pump rooms, four cargo oil pumps, steam deck machinery; Wallsend-Doxford opposed piston, two-stroke, oil engine, four cylinders 600mm diameter by 2320mm combined stroke, 3500 b.h.p. at 109 r.p.m., two multi-tubular Scotch boilers, two 80kW diesel-driven generators, one 50kW steam-driven generator. Trial, August 30th and 31st.

TEESWOOD, cargo ship; built by the Burntisland Shipbuilding Company, Ltd., for the Constantine Shipping Company, Ltd.; length between perpendiculars 214ft 6in, breadth 35ft 4in, depth moulded 16ft, deadweight 1550 tons, load draught 15ft 8¾in, speed 10½ knots; two large holds, raised quarter deck, machinery aft, electrical deck machinery; British Polar diesel engine, five cylinders, 340mm diameter by 570mm stroke, 800 b.h.p. at 250 r.p.m.; two 35kW and one 60kW diesel-driven generators.—Trial September 4th.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Tues., Oct. 20th.—54, Station Road, New Barnet, Herts, Presidential Address, "Education and Training in the Electrical Industry," C. T. Melling.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Sept. 30th.—LONDON SECTION: London School of Hygiene and Tropical Medicine, Keppel Street (Gower Street), W.C.1, "The Impact of Communication Theory on Television," D. A. Bell, 6.30 p.m.

Thurs., Oct. 1st.—N.W. SECTION: College of Technology, Manchester, "The Detection and Cure of Parasitic Oscillations in Radio and Electronic Equipment," H. Whalley, 7.15 p.m.

Thurs., Oct. 8th.—SCOTTISH SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "The Microwave Test Bench and its Components—a Practical Introduction to Waveguide Work," J. Bilbrough, 7 p.m.

ELECTRICAL POWER ENGINEERS' ASSOCIATION

Mon., Sept. 28th.—LONDON LOCAL GROUP: York Room, Caxton Hall, S.W.1, "Earthing," P. W. Cave, 7 p.m.

ENGINEERS' GUILD

Thurs., Sept. 24th.—METROPOLITAN BRANCH: Caxton Hall, Caxton Street, Westminster, S.W.1, Annual General Meeting, 6 p.m.

INCORPORATED PLANT ENGINEERS

Tues., Oct. 6th.—EDINBURGH BRANCH: 25, Charlotte Square, Edinburgh, Members' Papers, 7 p.m.——LONDON BRANCH: Royal Society of Arts, John Adam Street, Adelphi, W.C.2, "Patterns, Casings and Foundry Work: An Introduction," Barnet Levy, 7 p.m.

Wed., Oct. 7th.—SOUTHAMPTON BRANCH: Polygon Hotel, Southampton, "Oxygen in Industry," E. Ryalls, 7 p.m.

Thurs., Oct. 8th.—N.E. BRANCH: Roadway House, Oxford Street, Newcastle upon Tyne, "The Use of Paint in Factories," P. J. Gay, 7 p.m.

Mon., Oct. 12th.—DUNDEE BRANCH: Mathers Hotel, Dundee, "Factory Instrumentation," 7.30 p.m.

Tues., Oct. 13th.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "The Plant Maintenance Team's Visit to the U.S.A.," Colin Troup, 7.15 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Wed., Sept. 30th.—LONDON BRANCH: Waldorf Hotel, W.C.2, Presidential Address, B. Levy, followed by a Film and Report on "New Methods for Old," F. Hudson, 7 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., Sept. 22nd.—85, Minories, London, E.C.3, Presidential Address, Sir Gilmour Jenkins, 5.30 p.m.

INSTITUTE OF PETROLEUM

Wed., Oct. 14th.—26, Portland Place, London, W.1, Redwood Lecture, "The Friction of Solids," F. P. Bowden, 5.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Tues., Sept. 22nd.—N.E. ENGLAND GROUP: Royal County Hotel, Durham City, "The Maintenance of High-Speed Diesel Engines," H. L. Parrish, 7 p.m.

Wed., Sept. 23rd.—LONDON CENTRE: Visit by party of members to the works of Scammell Lorries, Ltd., Watford, Herts, 10.45 a.m.

Wed., Oct. 7th.—LONDON BRANCH: Royal Society of Arts, John Adam Street, London, W.C.2, Annual General Meeting, followed by "Transport in South Africa," T. F. Turton, 6.30 p.m.

INSTITUTE OF WELDING

Wed., Oct. 7th.—SLOUGH SECTION: Community Centre, Farnham Road, Slough, Bucks, "Organisation for Production of Welded Ships," D. M. Kerr, 7.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Sat. Oct. 10th.—Reynolds Hall, College of Technology, Manchester, George E. Davis Memorial Lecture, Norman Swindin, 3 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Oct. 5th.—S. MIDLAND CENTRE: Grand Hotel, Birmingham, Annual General Meeting, Chairman's Address and Conversazione, 6 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Oct. 6th.—39, Elmbank Crescent, Glasgow, Presidential Address, Sir William Wallace, 6.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Wed., Sept. 23rd.—Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, Presidential Address, R. C. Bond, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Tues., Oct. 6th.—AUTOMOBILE DIVISION: Storey's Gate, St. James's Park, London, S.W.1, Annual General Meeting, Address by the Chairman of the Division, 5.30 p.m.

Wed., Oct. 7th.—SOUTHERN BRANCH—SUSSEX AREA: Downbarton, Grand Avenue, Hove, 3, Committee Meeting, 7 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Tues., Oct. 6th.—ORDINARY MEETING: Institution of Electrical Engineers, Savoy Place, London, W.C.2, Chairman's Address, "Recent Developments in Subscribers' Apparatus and Services," F. C. Carter, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Sept. 21st.—DERBY SECTION: Midland Hotel, Midland Road, Derby, Presidential Address, W. C. Puckey, 7 p.m.

Tues., Sept. 22nd.—MANCHESTER GRADUATE SECTION: Room C3, Reynolds Hall, College of Technology, Manchester, 1, "Diecasting," T. Bradshaw, 7.15 p.m.

Wed., Sept. 23rd.—NOTTINGHAM SECTION: Works Visit to The Metal Box Company, Ltd., Colour Printing Department, Sutton-in-Ashfield, Notts, 2.30 p.m.

Sat., Sept. 26th.—SHREWSBURY SECTION: Works Visit to Josiah Wedgwood and Sons, Ltd., Barlaston, Stoke-on-Trent, 10 a.m.

Wed., Sept. 30th.—SHREWSBURY SECTION: Technical College, Shrewsbury, "The Engineer's Part in the Production of Pottery," J. Robinson, 7.30 p.m.

IRON AND STEEL INSTITUTE

Wed., Sept. 30th, to Wed., Oct. 7th.—Special Meeting in the Netherlands.

NEWCOMEN SOCIETY

Fri., Sept. 25th.—One-day Visit to Haddiscoe and Lound (near Lowestoft) to see grasshopper pumping engines.

ROYAL AERONAUTICAL SOCIETY

To-day, Sept. 18th.—LONDON: Anglo-American Conference. (See page 314.)

SOCIETY FOR WATER TREATMENT AND EXAMINATION

To-day and Sat., Sept. 18th and 19th.—Autumn Meeting in Manchester.

TELEVISION SOCIETY

Thurs., Sept. 24th.—Cinematrograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2, "Transistors and Other Crystal Valves," D. D. Jones, 7 p.m.